COLLINS

instruction book

Cedar Rapids Division | Collins Radio Company, Cedar Rapids, Iowa

180L-2, 180L-3, and 180L-3A Automatic Antenna Tuners

Guarantee

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts, or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory, transportation prepaid, provided

(a) Notice of the claimed defect is given Collins within one (1) year from date of delivery and goods are returned in accordance with Collins instructions.

(b) Equipment, accessories, tubes, and batteries not manufactured by Collins or from Collins designs are subject to only such adjustments as Collins may obtain from the supplier thereof.

(c) No equipment or accessory shall be deemed to be defective if, due to exposure or excessive moisture in the atmosphere or otherwise after delivery, it shall fail to operate in a normal or proper manner.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins or its authorized service center.

No other warranties, expressed or implied, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

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If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, insofar as applicable. If the item is thought to be defective, such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. (With respect to tubes we suggest that your adjustments can be speeded up if you give notice of defect directly to the tube manufacturer.) Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in the handling of your returned merchandise.

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Collins Radio Company
Service Division
Cedar Rapids, Iowa

INFORMATION NEEDED:

(A) Type number, name and serial number of equipment
(B) Date of delivery of equipment
(C) Date placed in service
(D) Number of hours of service
(E) Nature of trouble
(F) Cause of trouble if known
(G) Part number (9 or 10 digit number) and name of part thought to be causing trouble
(H) Item or symbol number of same obtained from parts list or schematic
(I) Collins number (and name) of unit subassemblies involved in trouble
(J) Remarks

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When ordering replacement parts, you should direct your order as indicated below and furnish the following information insofar as applicable. To enable us to give you better replacement service, please be sure to give us complete information.

ADDRESS:

Collins Radio Company
Service Division
Cedar Rapids, Iowa

INFORMATION NEEDED:

(A) Quantity required
(B) Collins part number (9 or 10 digit number) and description
(C) Item or symbol number obtained from parts list or schematic
(D) Collins type number, name and serial number of principal equipment
(E) Unit subassembly number (where applicable)

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Cedar Rapids Division | Collins Radio Company, Cedar Rapids, Iowa
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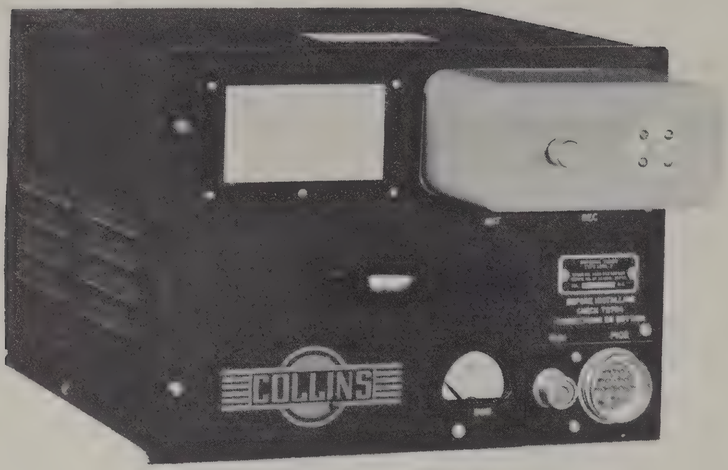
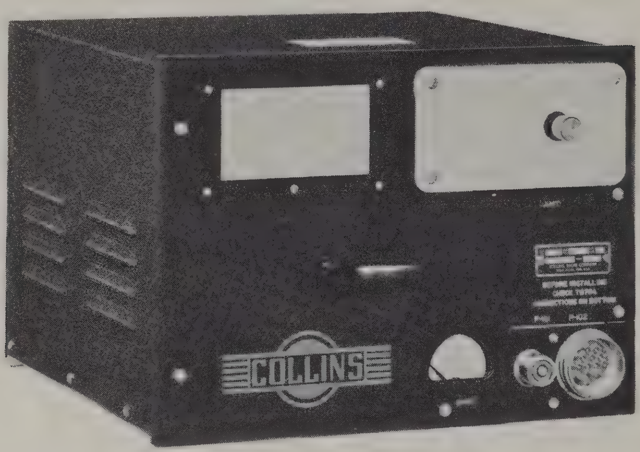
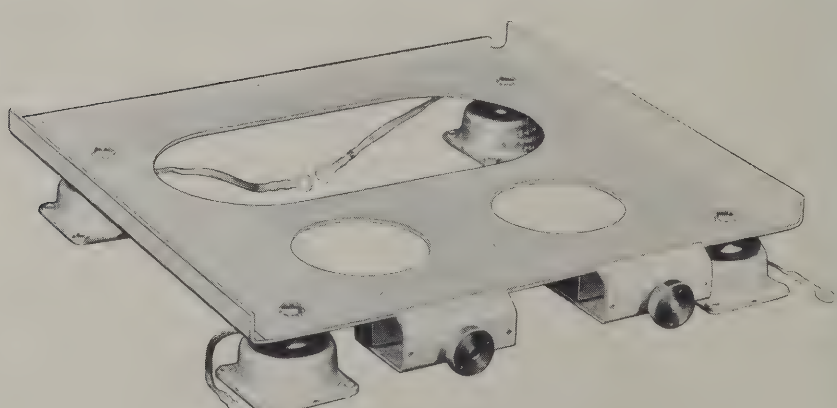


Automatic Antenna Tuner 180L-3 or 180L-3A



Automatic Antenna Tuner 180L-2



Mounting 350D-3

Figure 1-1. Applicable Equipment

SECTION I
GENERAL DESCRIPTION

1.1 PURPOSE OF HANDBOOK.

This handbook is published to aid in the installation, operation, and maintenance of Automatic Antenna Tuners 180L-2, 180L-3, and 180L-3A. It includes a description of the equipment, installation procedures, theory of operation, maintenance procedures, schematic diagrams, and modification data.

1.1.1 DIFFERENCE DATA, 180L-2, 180L-3, AND 180L-3A.

Automatic Antenna Tuners 180L-2, 180L-3, and 180L-3A are identical in purpose and design with the exception of an additional antenna transfer relay circuit included in Automatic Antenna Tuners 180L-3 and 180L-3A and an additional antenna grounding relay included in Automatic Antenna Tuner 180L-3A. Antenna transfer relay K712 is used to bypass the received signal directly to a receiver at such time as the associated transmitter in unkeyed. Automatic Antenna Tuner 180L-3 has wiring included for antenna grounding relay K713 which grounds the unused antenna in a dual installation. When relay K713 is included in Automatic Antenna Tuner 180L-3, it is called Automatic Antenna Tuner 180L-3A.

NOTE

Since the design differences of Automatic Antenna Tuners 180L-2, 180L-3, and 180L-3A will not affect the comparative functioning of these units, the material in this book referencing only the 180L-2 also applies to Automatic Antenna Tuners 180L-3 and 180L-3A.

1.1.2 MODIFICATION DATA.

The following modifications on the subassemblies of Automatic Antenna Tuner 180L-2 are the most recent modifications included in this book:

Discriminator	MOD 1
Cable	MOD 4
R-F Autotransformer	MOD 3
Servo Amplifier	MOD 4
Variable Capacitor	MOD 2
Variable Inductor	MOD 2
Discriminator	MOD 2
Servo Amplifier	MOD 5
Servo Amplifier	MOD 6
Servo Amplifier	MOD 7

Modifications on this equipment, to and including the modifications listed above, are discussed in section VIII along with restrictions to interchangeability of subassemblies brought about by these modifications.

1.2 PURPOSE OF EQUIPMENT.

Automatic Antenna Tuner 180L-2 performs functions of automatically resonating the aircraft antenna to frequencies determined by the associated transceiver and coupling the r-f signal between the transceiver and aircraft antenna. When resonating the aircraft antenna, the 180L-2 compensates for antenna reactance and maintains effective antenna resistance at 52 ohms.

The 180L-2 is designed for use with transceivers with a frequency range of 2 to 22 megacycles and a transmitter power output of 50 to 180 watts. Any fixed open-circuit wire antenna between 45 and 100 feet in length and most grounded-end antennas of similar length may be used, but some cases may require a different size shunt capacitor (C101) than supplied.

1.3 EQUIPMENT SUPPLIED.

Equipment supplied is covered in table 1-1 and illustrated in figure 1-1.

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED.

Table 1-2 lists the equipment required but not supplied as part of Automatic Antenna Tuner 180L-2. When installed in an aircraft, the antenna tuner will be connected to and used with auxiliary equipment similar to that listed in table 1-2.

TABLE 1-1. EQUIPMENT SUPPLIED

NAME OF UNIT	COLLINS PART NUMBER	OVER-ALL DIMENSIONS (inches)	WEIGHT (lb)
Antenna Tuner 180L-2	506-1199-004	10-3/8 w x 7-13/16 h x 11-3/8 d	20
or			
Antenna Tuner 180L-3	522-0092-004	10-3/8 w x 7-13/16 h x 13-7/8 d	21
or			
Antenna Tuner 180L-3A	522-0293-004		
Mounting 350D-3	505-2782-002	10-1/4 w x 2 h x 11-1/4 d	1.25

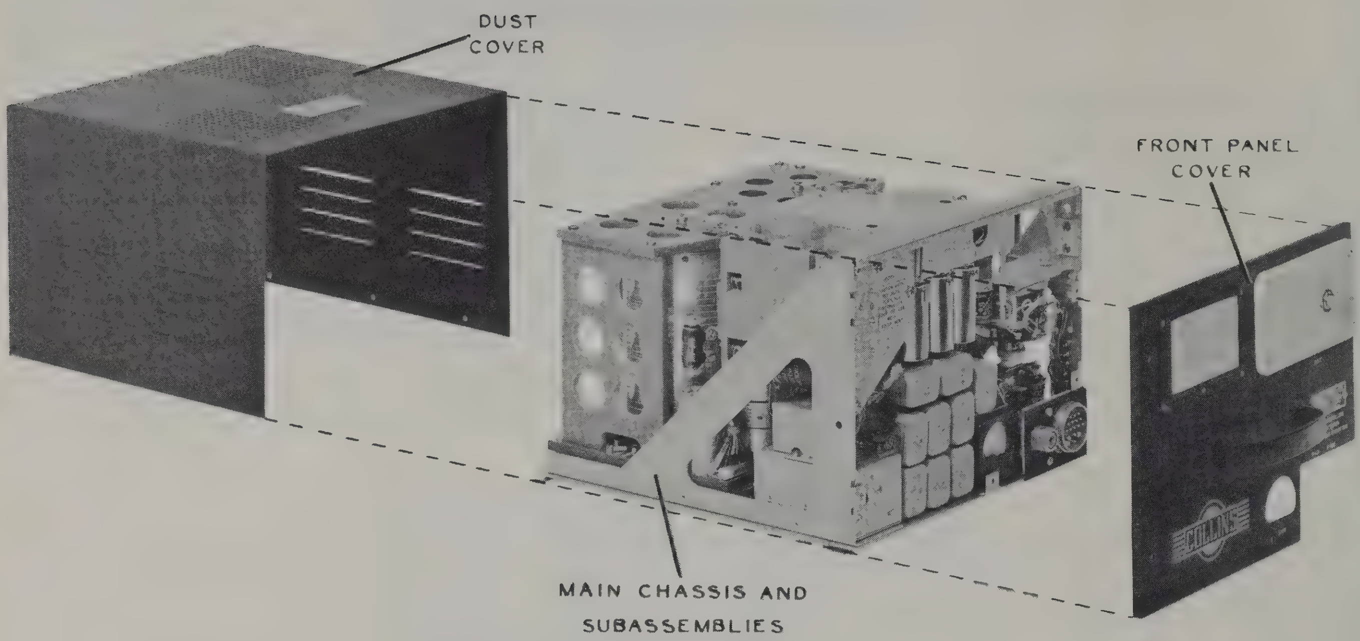


Figure 1-2. Automatic Antenna Tuner 180L-2, Front Panel and Dust Cover Removed

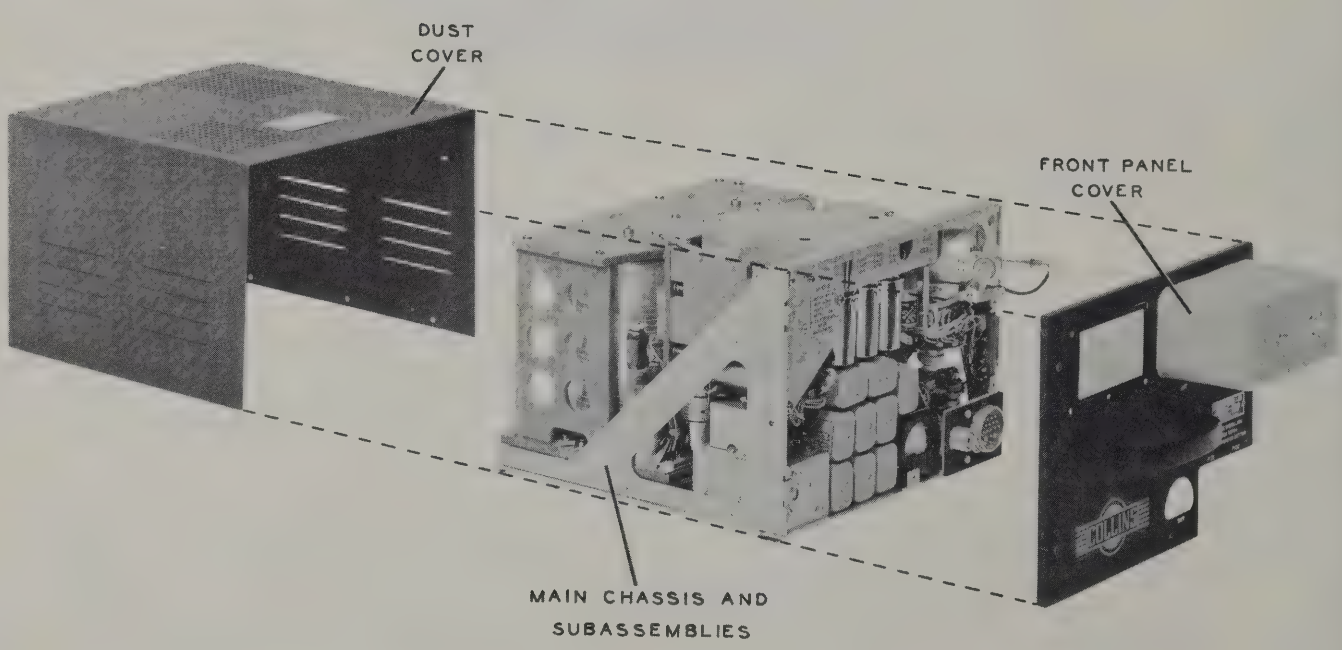


Figure 1-3. Automatic Antenna Tuner 180L-3 or 180L-3A, Front Panel and Dust Cover Removed

1.5 DESCRIPTION OF COMPONENTS.

Refer to figures 1-2 and 1-3. Automatic Antenna Tuners 180L-2, 180L-3, and 180L-3A consist of a front panel cover, a dust cover, and a main chassis upon which are mounted five removable subassemblies. Power and control connections are made through a multicontact connector, J102, located at the lower right corner of the main chassis frame. The r-f connection is made through connector J101 which is located next to power and control connector J102. The antenna is connected to the clamp-type connector, E102, which is located at the upper right-hand corner of the front panel cover. In addition, Automatic Antenna Tuners 180L-3 and 180L-3A contain an auxiliary receiver connector located next to antenna connector E102. This connector couples the antenna signal directly to the receiver without passing it through the 180L-3 or 180L-3A tuning circuits. An SWR meter

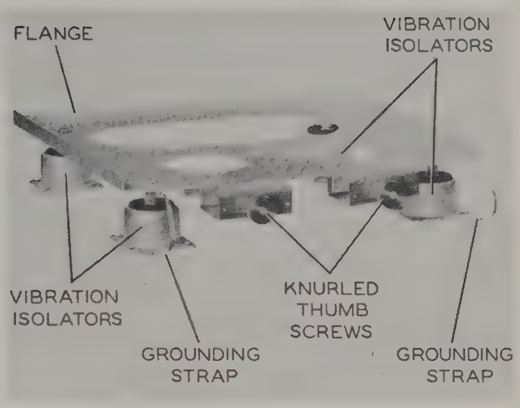


Figure 1-4. Mounting 350D-3, Front Oblique View

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

NAME OF UNIT	NOMENCLATURE	REQUIRED CHARACTERISTICS
Transceiver	618S-1, 618S-4, or equivalent	Frequency range, 2 to 22 megacycles; power output, 50 to 180 watts; output impedance, 52 ohms.
Antenna		Typical long-wire, 45 to 100 feet in length.
R-F Cable	RG-8/U	Coaxial cable; interconnects J101 and r-f output connector of associated transceiver.
REC Cable (180L-3 of 180L-3A only)	RG-58/U	Coaxial cable; interconnects connector J103 (REC) of 180L-3 or 180L-3A and input connector of associated receiver or receiver section of transceiver.
Power and Control		16-connector cable; must be fabricated from bulk supplies (refer to paragraph 2.3.1.1) or may be obtained from manufacturer, Collins part number 424-0006-00.
R-F Connector P101	NAVY 49195	Mates J101.
R-F Connector P103 (180L-3 or 180L-3A only)	UG-88/U	Mates J103 (REC) of 180L-3 or 180L-3A.
Power and Control Connector P102	CANNON SK-C16-23C-1/2 or SK-C16-23 1/2-AC or SK-C16-21 1/2-AC	Mates J102.

also is located on the front of the main chassis and is viewed through a cutaway area in the front panel cover.

Mounting 350D-3 (refer to figure 1-4) is designed to retain the antenna tuner in the aircraft. It includes two knurled thumb screws which tighten clamps into a flange located on the front of the antenna tuner. The rear of Mounting 350D-3 also contains a flange which mates with the rear of the antenna tuner chassis. Four grounding straps are provided which are secured under the vibration isolater feet to assure good electrical contact.

1.6 TECHNICAL SUMMARY.

The following are a listing of the electrical characteristics of Automatic Antenna Tuner 180L-2:

Frequency coverage.	2 through 22 megacycles
R-f input power. .	50 - 180 watts average 500 watts PEP
Duty cycle	5 minutes on, 5 minutes off
Power requirements. . .	27.5 v d-c at 3.5 amp max 115 v, 400 cps, single phase, at 20 va 250 v d-c at 35 ma max or 400 v d-c at 35 ma max
Input impedance. .	52 ohms
Power output . . .	$P_O = P_I X\ 0.75\ X\ \frac{275}{275 + Q_A}$

Where: P_O is power output

P_I is power input

$$Q_A = \frac{R_A\ 2 - X_A\ X_C + X_A{}^2}{R_A\ X_C}$$

X_C = Absolute value of reactance of a 30-uuf capacitor for the 180L-3 and 180L-3A and 20-uuf capacitor for the 180L-2 at the frequency at which the efficiency calculation is to be made.

R_A = Antenna resistance

X_A = Antenna reactance (use appropriate sign)

Table 1-3 lists the vacuum tubes and crystal rectifiers supplied as part of Automatic Antenna Tuner 180L-2.

TABLE 1-3. CRYSTAL RECTIFIER AND TUBE COMPLEMENT

DESIGNATION	TYPE	DESCRIPTION	FUNCTION	LOCATION
CR201	1N39B	Crystal rectifier	Phasing discriminator rectifier	Discriminator subassembly
CR202	1N39B	Crystal rectifier	Phasing discriminator rectifier	Discriminator subassembly
CR203	1N39B	Crystal rectifier	Loading discriminator rectifier	Discriminator subassembly
CR204	1N39B	Crystal rectifier	Loading discriminator rectifier	Discriminator subassembly
CR205	CK707	Crystal rectifier	Avc rectifier	Discriminator subassembly
CR701	CK707	Crystal rectifier	Swr meter rectifier	Front panel; Terminal board TB701
V601	5751	Dual triode	V601A, first loading amplifier; V601B, first phasing amplifier	Servo amplifier subassembly
V602	5751	Dual triode	V602A, second loading amplifier; V602B, second phasing amplifier	Servo amplifier subassembly
V603	5814	Dual triode	V603A, third loading amplifier; V603B, third phasing amplifier	Servo amplifier subassembly

SECTION II
INSTALLATION

NOTE

The following installation procedures referencing only the 180L-2 also apply to Automatic Antenna Tuners 180L-3 and 180L-3A.

2.1 UNPACKING AND INSPECTING THE EQUIPMENT.

Carefully remove the equipment from the packing boxes. Save all internal packaging, filler, blocking, and bracing to be used with the original packaging containers when the equipment is repacked for storage or shipment. Inspect each unit for evidence of damage during shipment or missing components. All claims must be filed promptly with the transportation company involved.

2.1.1 VISUAL INSPECTION.

Perform the following operations upon finishing with the unpacking of the equipment:

a. Remove the front panel and dust cover from the antenna tuner. The dust cover is secured by six Phillips-head screws and lock washers, and the front panel cover is secured by five Phillips-head screws and lock washers. (If the 180L-2 is being inspected, it is also necessary to loosen the setscrew of E507 in order to remove the front panel cover. Refer to figure 5-11 for the location of E507.)

b. Inspect all tubes for proper seating in their sockets, and check the tube shields for mechanical security.

c. Inspect the plug-in relays for proper seating.

d. Inspect mechanical parts, such as gears and rollers, for evidence of damage.

e. Inspect the main chassis and front panel for dirt, metal scraps, or condensation.

f. Inspect the roller of transformer T301 and adjust if necessary. (Refer to paragraph 5.3.5.3.1.)

2.2 TEST EQUIPMENT.

The equipment listed in table 2-1 or equipment equal or superior characteristics must be used in the pre-installation bench tests of paragraph 2.3 and in other tests throughout this handbook.

TABLE 2-1. TEST EQUIPMENT REQUIRED

DESCRIPTION	NOMENCLATURE	COLLINS PART NUMBER
Transceiver	618S-1 or 618S-4	522-0060-006 or 522-1020-006
Power Supply	416W-1	522-0053-006
Radio Set Control	614C-2	522-0147-005
Mounting	350S-1 or 350S-3	522-0059-005 or 522-0184-005
Mounting	350T-1	522-0052-004
Tube Tester	Hickok Model 539A	
Vacuum-Tube Voltmeter	Hewlett-Packard Model 410B	
Multimeter	Simpson 260	

TABLE 2-1. TEST EQUIPMENT REQUIRED (Cont)

DESCRIPTION	NOMENCLATURE	COLLINS PART NUMBER
Dummy Load; 52 ohms	Bird Model 82	
Test Battery; 1.5 volts (2 needed)		
Potentiometer; 1 megohm, 1/2 watt		
R-F Cable	RG-8/U	
R-F Cable (needed for 180L-3 or 180L-3A only)	RG-58/U	
Power and Control Cable	(See paragraph 2.3.1.1.)	
R-F Connector	Navy 49195	357-9006-00
R-F Connector (needed for 180L-3 or 180L-3A only)	UG-88/U	357-9018-00
Power and Control Connector	Cannon SK-C16-23C-1/2	371-0012-00
	or SK-C16-23 1/2-AC	371-3070-00
	or SK-C16-21 1/2-AC	371-3080-00
Resistance Decade		
Microphone		
Head Set		
Power Source: 27.5 volts d-c at 3.5 amperes		
Power Source: 115 volts, 400 cps, at 20 volt-amperes		

2.3 PREINSTALLATION BENCH TEST.

The preinstallation bench test should be performed using the equipment listed in table 2-1 and a test bench harness that simulates the cabling between components in an actual aircraft installation. Figure 2-1 illustrates such a test bench harness, and paragraph 2.3.1 provides information on cable fabrication. After fabricating the test bench harness, do not connect the antenna tuner into the harness until step e of the preliminary operations under test procedures, paragraph 2.3.2.

2.3.1 CABLE FABRICATION.

Each of the cables illustrated in figure 2-1 must be fabricated using bulk supplies. Paragraphs 2.3.1.1 through 2.3.1.4 give required data concerning wire sizes, connector types, and fabrication procedures for all cables used to connect the antenna tuner into the test bench harness. For data concerning the cabling of Transceiver 618S-1 or 618S-4, refer to the instruction book for these units.

2.3.1.1 POWER AND CONTROL CABLE. The power and control cable must be fabricated from bulk supplies. A type SK-C16-23C-1/2 or SK-C16-23 1/2-AC Cannon connector is required for P102. All necessary data concerning connections and wire sizes may be obtained from the external wiring diagram of figure 7-3. This cable also may be obtained from the manufacturer, Collins part number 424-0006-00.

2.3.1.2 COAXIAL CABLE RG-8/U. Coaxial cable RG-8/U is used to provide r-f connection between the

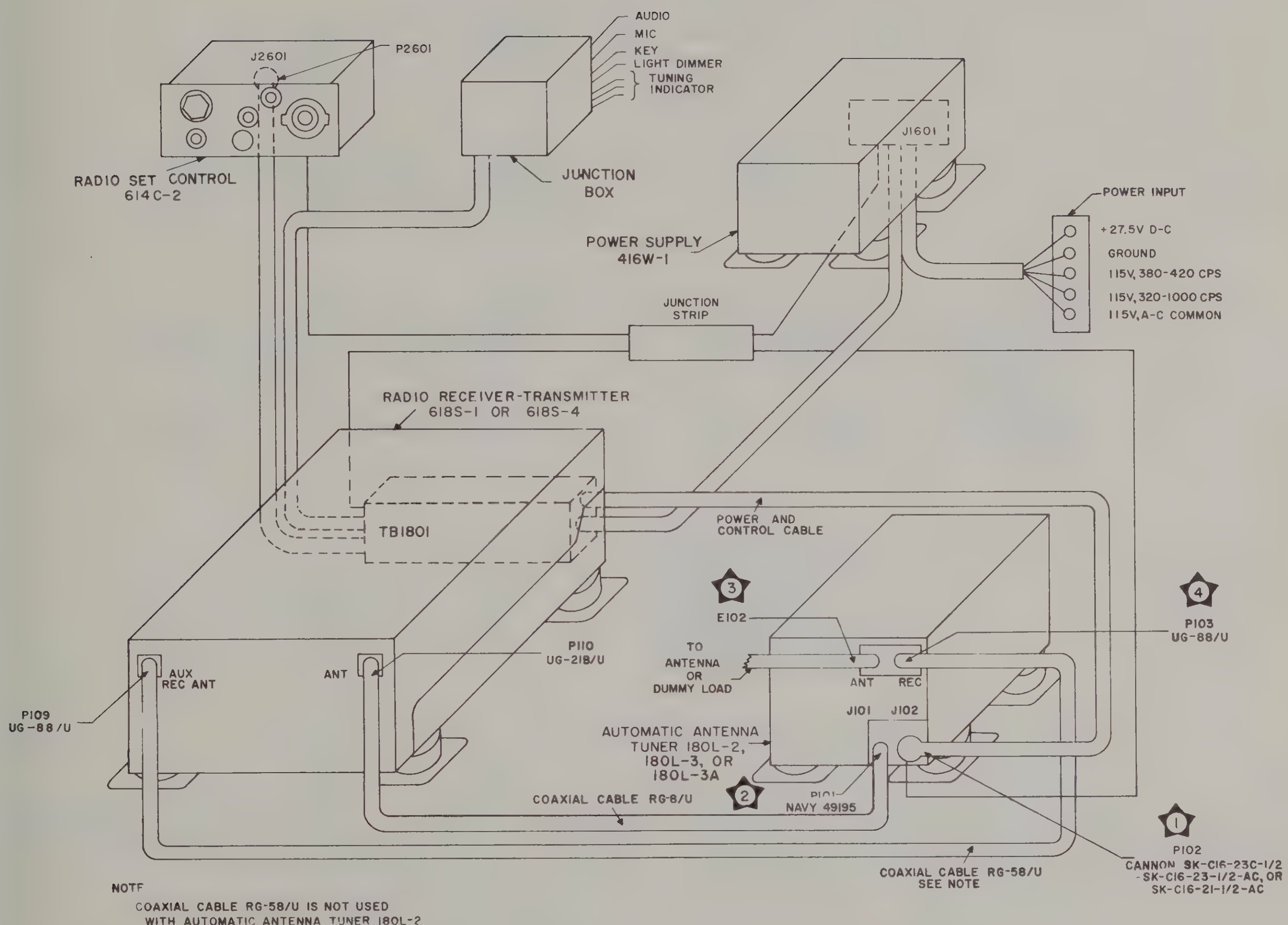


Figure 2-1. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Typical Test Bench Harness

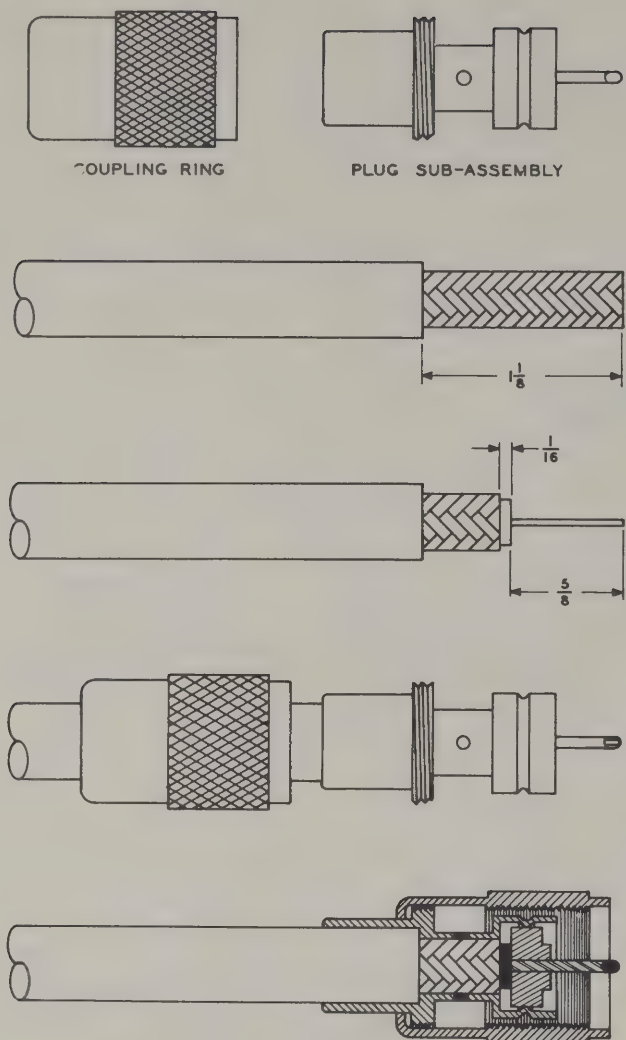


Figure 2-2. Assembly of Navy 49195 Connector to Coaxial Cable RG-8/U

output of the associated transceiver and the r-f input, J101, of the antenna tuner. Navy 49195 connector should be used with coaxial cable RG-8/U, and figure 2-2 illustrates the method of connecting the RG-8/U cable to the Navy 49195 connector.

2.3.1.3 COAXIAL CABLE RG-58/U. Coaxial cable RG-58/U is used to provide connection between the REC terminal, J103, of the 180L-3 or 180L-3A and the receiver section of the associated transceiver. A type UG-88/U connector is required with coaxial cable RG-58/U, and figure 2-3 illustrates the method of connecting the RG-58/U cable to the UG-88/U connector. Automatic Antenna Tuner 180L-2 does not employ the REC terminal, and coaxial cable RG-58/U is not required.

2.3.1.4 ANTENNA CABLE. The antenna lead-in is connected to the ANT connector, E102, of the antenna tuner. The antenna lead-in should be flexible, should clear all surrounding surfaces and areas by at least four inches, and should have enough slack to permit free movement of the antenna tuner on mounting 350D-3. The ANT connector will accommodate wire sizes between 10 AWG and 16 AWG.

2.3.2 TEST PROCEDURES.

The following test procedures include a mechanical cycle test and tuning test. Before proceeding with these tests, which are outlined in paragraphs 2.3.2.1 and 2.3.2.2, perform the following preliminary procedures:

a. Remove the dust cover.
b. Manually rotate r-f autotransformer T301 until roller E303 is approximately three turns from maximum. (Refer to figures 5-11 and 5-12.)
c. Set the antenna tuner on its side, and observe terminal board TB704. TB704 should be connected for automatic keying and 250 volts B-plus. If TB704 is not connected as indicated in A of figure 2-4, remove the transparent cover, and connect the shorting straps correctly.

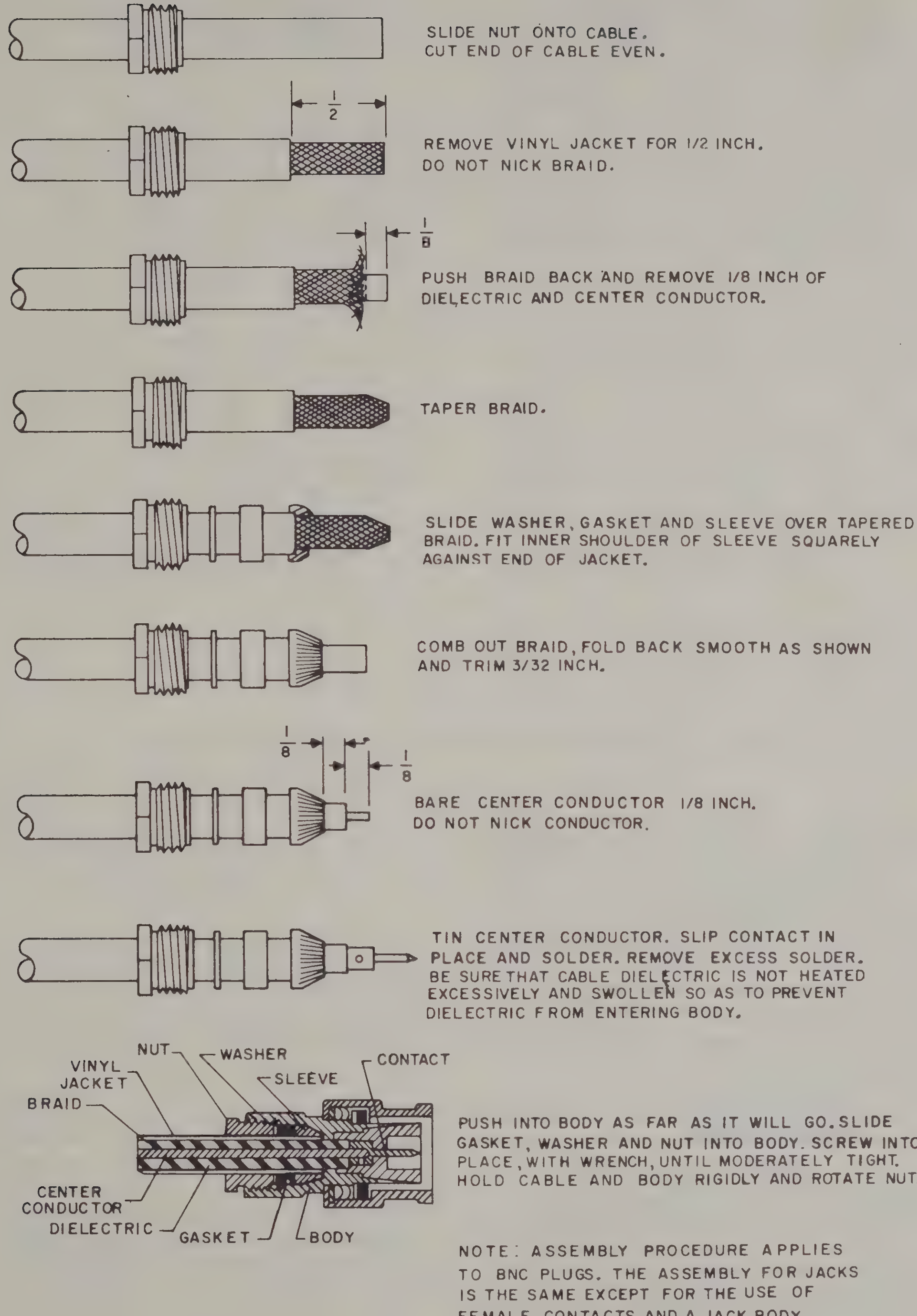


Figure 2-3. Assembly of UG-88/U Connector to Coaxial Cable RG-58/U

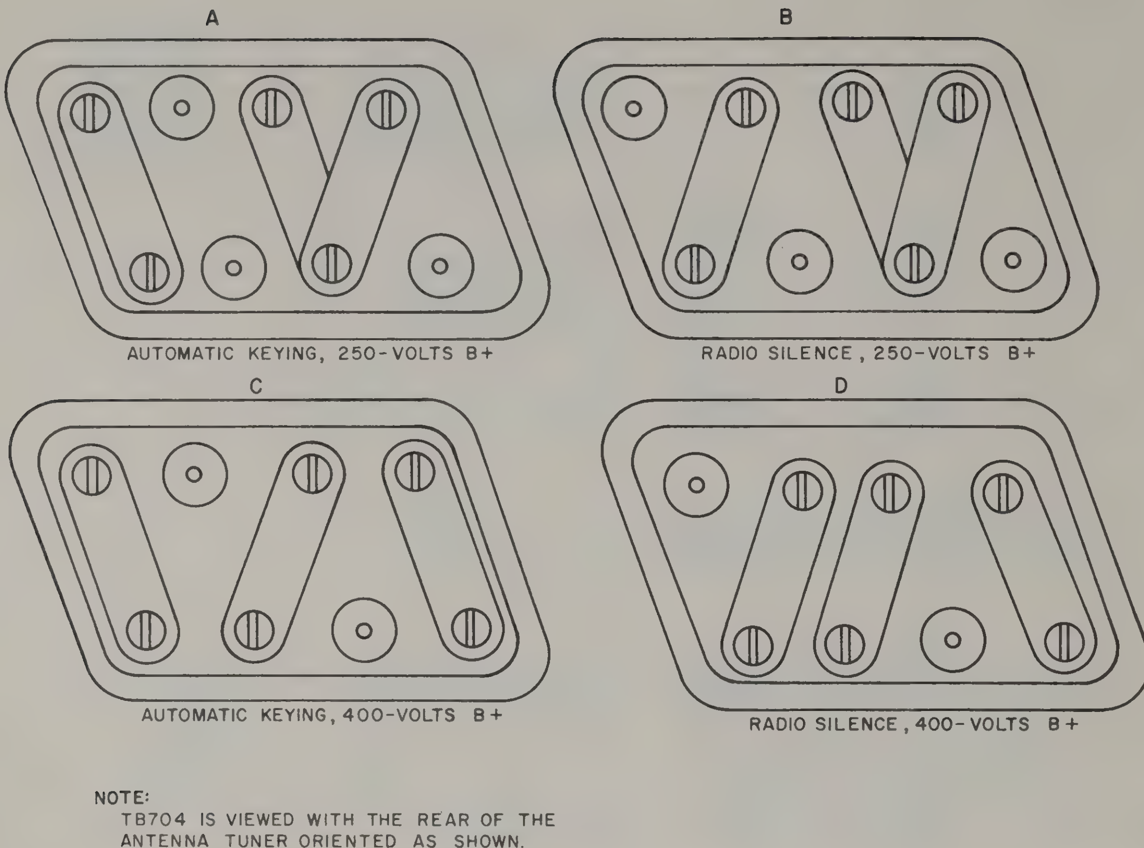


Figure 2-4. Terminal Board TB704, Alternate Connections

d. If the 180L-2 is being tested, terminals 2 and 4 of relay K1501 of the 618S-1 or 618S-4 Transceiver should be jumpered. If the 180L-3 or 180L-3A is being tested, these terminals should be disconnected.

e. Connect the antenna tuner in the test bench harness illustrated in figure 2-1. Do not connect the primary power sources until ready to perform the test procedures of paragraphs 2.3.2.1 and 2.3.2.2. The dummy load is not required for these tests.

WARNING

The r-f and d-c voltages encountered in this unit are dangerous to life. When in operation, either in or out of the protective covers, special care should be taken to avoid contact with the antenna lead-in or the antenna connector, E102. Also, use special care to avoid touching detailed parts and wiring carrying B-plus voltages. From a mechanical standpoint, clothing and rags should be kept free from the moving gears and parts during the tuning cycle.

2.3.2.1 MECHANICAL CYCLE TEST. Perform the preliminary procedures outlined in paragraph 2.3.2.

CAUTION

Continuous tuning of the 180L-3 or 180L-3A control circuits may result in damage to relay K712. The time element involved in the following test is sufficiently small to avoid this; however, unnecessary tuning should be avoided.

Close the primary power source switches, and rotate the OFF PHONE CW switch of the radio set control to the PHONE position. Allow sufficient time for warmup. Next, rotate the channel selector of the radio set control to a position corresponding to 2.0 megacycles, and observe the 180L-2 tuning cycle for results listed in the following steps. (Refer to figures 5-11 and 5-12 throughout the following steps.)

NOTE

The sequence of operation outlined in steps a through i is the correct time sequence. Because of the difficulty in observing each of the functions as they first happen, the tuning circuits may be allowed to run continuously

(observing caution) for observation. It should be understood, however, that relay K710 will become energized following the first complete sequence, and that time-delay relay K711 will open between 30 and 55 seconds after channel selection.

a. Roller E303 of T301 should run to the center tap position (plus or minus one turn) and stop. The center tap position is identifiable by the separation point of the two T301 windings.
b. Variable inductor L401 should run to minimum (all of the tape on the metal drum).
c. Variable capacitor C501 should run to minimum (bellows in the downward position).
d. Variable inductor L401 should run six turns from minimum (six turns on the ceramic drum).
e. Variable capacitor C501 should run to maximum (bellows in the upward position).
f. Variable inductor L401 should run to maximum (all of the tape on the ceramic drum).
g. Relay K710 should be energized, driving contact E701 to the contact of shunt capacitor C101.
h. The mechanical cycle should repeat as outlined in steps a through f with K710 remaining energized.
i. Time-delay relay K711 should open between 30 and 55 seconds after channel selection causing all motion to stop.

NOTE

If the 180L-2 has not tuned for several minutes and time-delay relay K711 has cooled completely, a time interval of 45 to 55 seconds will be required before K711 opens. The 30-second period referred to in step i of this paragraph will be true only if the 180L-2 is tuned approximately 30 seconds after previous tuning.

Normally, when ANT connector E102 is not terminated and the selected frequency is 2.0 megacycles, the 180L-2 tuning circuits will continue to operate until time-delay relay K711 opens, as outlined in steps a through i. If the 180L-2 does not function as stated in steps a through i, turn the power off and loosen the setscrew of E408. Remove the lead from E408, and repeat the test procedure outlined in this paragraph.

2.3.2.2 TUNING TEST. Perform the following operations after determining that the test channels are free of radio communication:

a. Replace the dust cover.
b. Connect the 180L-2 as outlined in the preliminary procedures of paragraph 2.3.2.
c. Connect the ANT connector, E102, to an ungrounded straight-wire antenna between 45 and 100 feet in length.
d. Select a channel corresponding to 2 megacycles on the radio set control, and check for indications as listed in steps e through i.
e. The tuning indicator lamp of the radio set control should either light or go off during the tuning cycle, depending upon the external wiring.
f. Check to see that Radio Transceiver 618S-1 or 618S-4 is automatically keyed throughout the 180L-2 tuning cycle. This may be accomplished by selecting CW operation and monitoring the 400-cps sidetone signal at the 618S-1 or 618S-4 PHONE jack.
g. Allow the 180L-2 to complete the tuning cycle. The time required should not exceed 30 seconds.
h. Manually key the transmitter and observe the 180L-2 SWR meter. The SWR meter should indicate below the red mark after tuning is complete.
i. Rotate the meter selector of the 618S-1 or 618S-4 to the P.A. PL. position. Manually key the transmitter, and observe the indication on the front panel meter of the 618S-1 or 618S-4. The indication should be within the red area.
j. Repeat the test procedures outlined in steps d through i for 6, 12, 16, and 22 megacycles.
k. Disconnect the 180L-2 from the test bench harness, and replace the dust cover.

2.4 INSTALLATION IN AIRCRAFT.

The individual components of Auotmatic Antenna Tuner 180L-2 must be mounted in a location convenient to the existing facilities of the aircraft. No attempt is made in this instruction book to present complete installation procedures, since the particular type of aircraft and associated equipment involved will determine the installation procedure. A general procedure is outlined in paragraphs 2.4.1 and 2.4.2.

2.4.1 LOCATION.

Because the 180L-2 requires no operation during flight and access for maintenance purposes only is required, it may be installed at a remote point in the aircraft. A mounting location should be selected that is well ventilated and will allow removal and replacement of the unit as required. Cabling requirements should be taken into consideration in choosing the location. The 180L-2 should be located no more than two feet away from the antenna feedthrough insulator in the aircraft in order to obtain maximum radiating efficiency from the antenna and reduce the hazard to personnel due to high r-f voltages. Avoid orienting the 180L-2 so that personnel may easily come in contact with the antenna terminal, E102, or the antenna lead-in wire. In addition, rubber cap E104 may be used over connector E102 to help insulate that connector. Clearance of one and one-half inches minimum from all surfaces is recommended for antenna connector E102. Refer to figure 7-1 for the outline and mounting dimensions of both the 180L-2 and the 350D-3. Refer to figure 7-2 for the outline and mounting dimensions of the 180L-3 or 180L-3A.

2.4.2 MOUNTING.

Mount Automatic Antenna Tuner 180L-2 as outlined in the following steps:

a. Select a suitable location for installation. Refer to paragraph 2.4.1.

b. Throughly clean the selected mounting surface and spot-face the surface area contacted by the vibration isolator feet of Mounting 350D-3.

c. With 350D-3 grounding straps in position beneath the vibration isolator feet, secure with sixteen 9/64-inch bolts.

d. Loosen the knurled thumb nuts of Mounting 350D-3 by rotating in a counterclockwise direction.

e. Place the 180L-2 in position on Mounting 350D-3, and mate with the flange at the rear of the 350D-3.

f. Inspect the front of Mounting 350D-3 to see if the clamps (behind the knurled thumb screws) are mated correctly with the 180L-2 front flange.

g. Tighten the knurled thumb screws, and secure them to the clamps with safety wire.

2.5 POSTINSTALLATION INSPECTION.

After the 180L-2 equipment has been installed in the aircraft, a complete inspection should be made before power is applied. In general, the 180L-2 installation should be checked as follows:

a. Check all cable connection making sure the locking rings are tight.

b. Check the wires entering the multiple power and control connector to be sure the insulation has not been cut back too far, causing the wires to short together.

c. Check the mechanical security of the 180L-2 on the mounting.

d. Check the grounding straps to Mounting 350D-3 for good electrical contact.

e. Check all the cabling between the associated equipment and the 180L-2.

2.6 PREFLIGHT TEST.

The preflight test is designed to make certain the equipment is operating properly prior to flight. The aircraft should be located outside the hangar, and tests should be performed with auxiliary power applied. Perform the following operations:

a. Turn on the primary power source switch.

b. Apply power to the transceiver used and the 180L-2.

c. Rotate the OFF PHONE CW switch of the radio set control to the PHONE position, and allow at least five minutes for warmup.

d. Rotate the channel selector of the radio set control to a random channel, making sure that the channel used is free of other radio communication.

e. Automatic Antenna Tuner 180L-2 should begin the tuning cycle unless connected for radio silence. In this case, the tuning cycle will not start until the transmitter is keyed.

CAUTION

The maximum duty cycle of Automatic Antenna Tuner 180L-2 is five minutes r-f on and five minutes r-f off. Do not key the transmitter beyond this time limit.

f. Observe the tuning indicator lamp of the radio set control. The tuning indicator lamp should either light or go off during the 180L-2 tuning cycle, depending upon the external wiring.

g. The 180L-2 should complete the tuning cycle in less than 30 seconds.

h. After completion of the tuning cycle, observe the 180L-2 SWR meter. The SWR meter should indicate below the red mark.

i. Select several random channels within the 2- to 22-megacycle range, and repeat the checks outlined in steps e through i for each new channel.

NOTE

After completion of a tuning cycle, wait at least 30 seconds before selecting a new channel to prevent overheating time-delay relay K711.

After the 180L-2 has passed the preflight test, a test of actual communication is advisable. Use at least three frequencies within the range of 2 to 22 megacycles, and establish two-way communication with the operation tower or with ground stations 150 miles or more distant.

SECTION III
OPERATION

3.1 INTRODUCTION.

Because all operation of Automatic Antenna Tuners 180L-2, 180L-3, and 180L-3A is performed automatically, this section of the handbook is not applicable.

SECTION IV
PRINCIPLES OF OPERATION

4.1 GENERAL.

NOTE

The following principles of operation referencing only the 180L-2 also apply to Automatic Antenna Tuners 180L-3 and 180L-3A.

Automatic Antenna Tuner 180L-2 performs the functions of automatically resonating the aircraft antenna to frequencies determined by the associated transceiver and coupling the r-f signal between the transceiver and the aircraft antenna. When resonating the aircraft antenna, the 180L-2 compensates for antenna reactance and maintains the effective antenna resistance at 52 ohms.

The 180L-2 is designed for use with transceivers with a frequency range of 2 to 22 megacycles and a transmitter power output of 50 to 180 watts. Any fixed open circuit wire antenna between 45 and 100 feet in length and most grounded-end antennas of similar length may be used, but some cases may require a different size shunt capacitor (C101) than supplied.

For a block diagram of Automatic Antenna Tuner 180L-2, refer to figure 4-1. For purposes of explanation, assume the associated transceiver has been channeled. The transceiver provides retune information to the control circuits of Automatic Antenna Tuner 180L-2. The r-f signal of the newly selected channel is passed through the SWR indicator bridge circuit, actuating SWR indicator meter M701. When tuning within the 180L-2 has been completed and the antenna has been tuned correctly, meter M701 normally reads below the red area. At the output of the SWR indicator bridge circuit, the r-f signal is passed through the primary of discriminator transformer T201. The secondary of T201 connects to the loading discriminator and phasing discriminator circuits.

The phase relationship of the voltage and current is determined in the phasing discriminator circuit, and

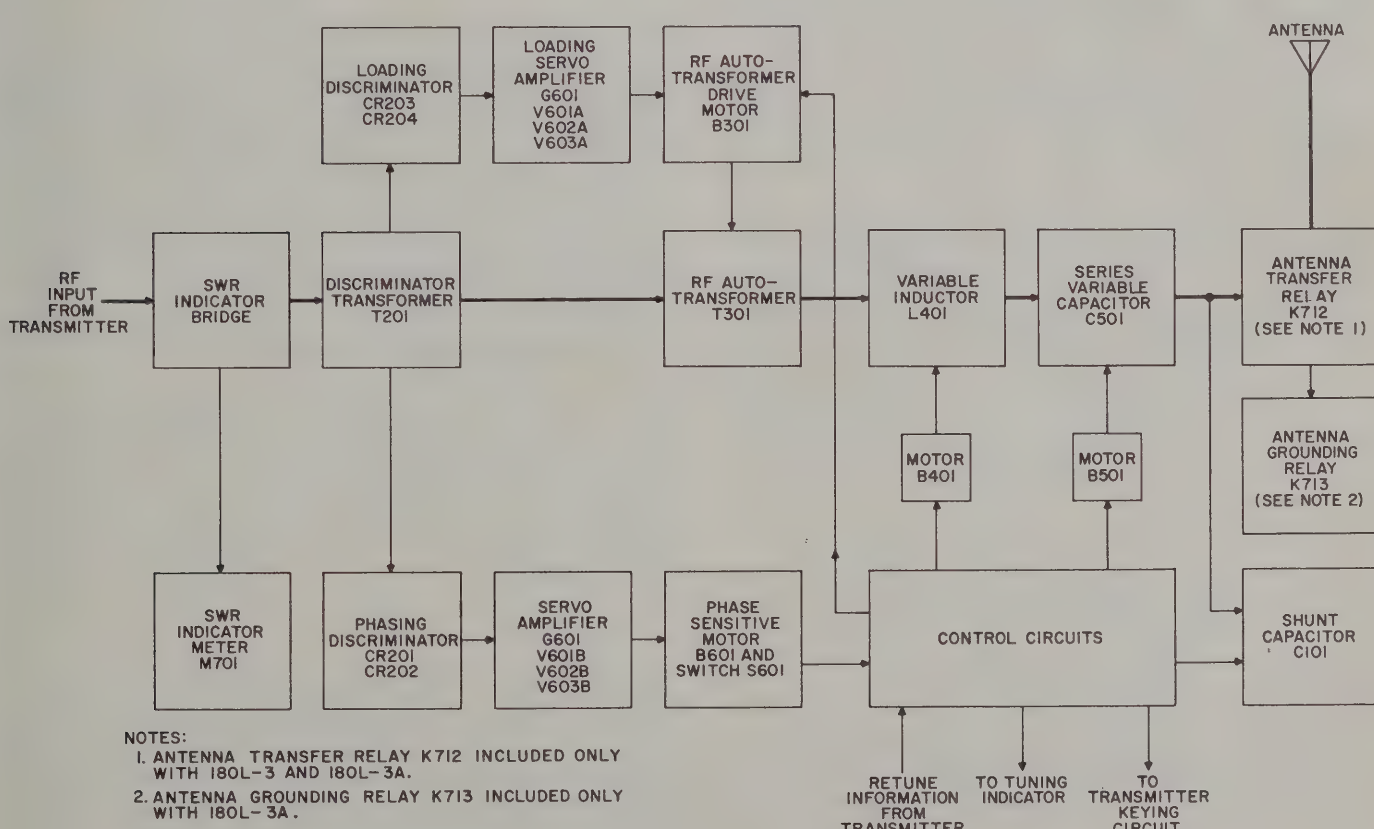


Figure 4-1. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Block Diagram

an antenna which appears inductive or capacitive to the transmitter will result in a d-c output voltage from the phasing discriminator circuit, polarity dependent upon the type of reactance seen by the transmitter. This d-c voltage is converted into a 400-cps square-wave signal by chopper G601 and amplified by V601B, V602B, and V603B. The 400-cps output signal from the phasing servo-amplifier circuit is used to drive motor B601. The direction of rotation of motor B601 depends upon the polarity of the d-c input voltage and therefore, upon the type of reactance seen by the transmitter or phasing discriminator. Motor B601 operates a switch, S601, which supplies information to the control circuits concerning the type of reactance seen by the transmitter. The control circuits operate motors B401 and B501, driving the variable inductor and series variable capacitor, thus compensating for any reactance seen by the transmitter.

The input r-f signal is also applied to the loading discriminator circuit through discriminator transformer T201. The loading discriminator produces a d-c output voltage, polarity dependent upon the amount of impedance seen by the transmitter (above or below 52 ohms). The d-c signal is converted into a 400-cps square-wave signal by chopper G601 and amplified by V601A, V602A, and V603A. The output of the loading servo amplifier is a 400-cps signal, phase dependent upon the polarity of the leading servo-amplifier input. The 400-cps signal is used to drive one phase of r-f autotransformer drive motor B301. The other B301 phase is supplied by the 400-cps power source.

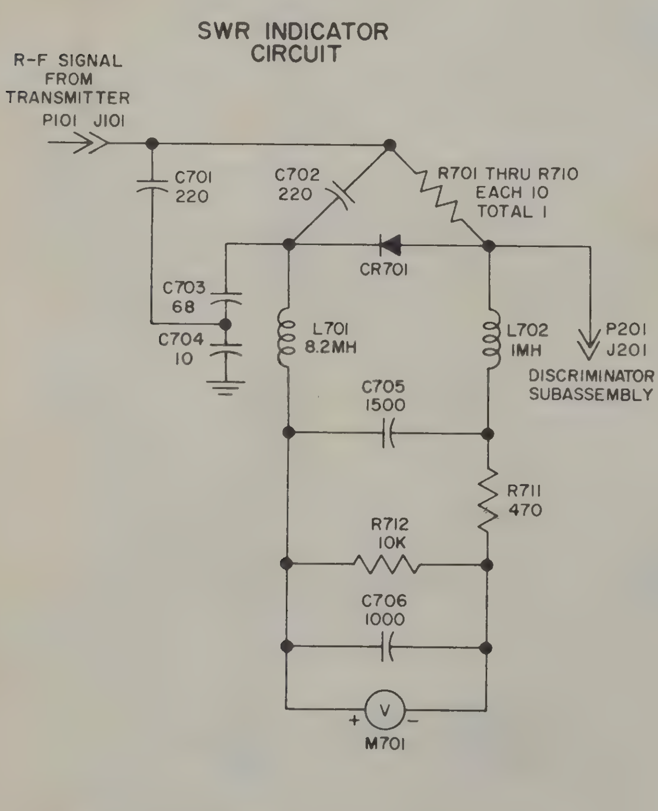


Figure 4-2. SWR Indicator Bridge Circuit, Simplified Schematic Diagram

The resultant direction of rotation of B301 is thus determined by the impedance seen by the loading discriminator or transmitter. The r-f autotransformer, T301, is driven by B301 in the proper direction to compensate for the antenna impedance, and the load seen by the transmitter is thus maintained at 52 ohms.

In some cases, the reactance or impedance presented to the transmitter may be beyond the range of T301, L401, and C501. To allow for this possibility, a shunt capacitor, C101, is included at the output of C501. If the 180L-2 fails to tune, this shunt capacitor is switched in by the control circuits, and the 180L-2 repeats the tuning cycle. For some installations, it may be necessary to select a different value of shunt capacitor than is supplied.

The main r-f signal from the transmitter is passed through r-f autotransformer T301, through variable inductor L401, through variable capacitor C501, and through antenna transfer relay K712 to the antenna. Relay K712 is included only in Automatic Antenna Tuners 180L-3 and 180L-3A, and is used to bypass the received signal directly to the receiver when the transmitter is not keyed. (Refer to paragraph 4.5.1.) Antenna grounding relay K713 is included only in Automatic Antenna Tuner 180L-3A, and is used to ground the unused antenna in a dual installation. (Refer to paragraph 4.5.2.) With Automatic Antenna Tuner 180L-2, both the received and transmitted signals are passed through the 180L-2 tuning circuits.

The control circuits provide an automatic keying circuit to the transmitter during the 180L-2 tuning cycle, which maintains the transmitter in the key-down position until tuning is complete. Also, an external tuning indicator circuit is provided. This external tuning indicator circuit is normally wired so that an indicator lamp is lighted during the 180L-2 tuning cycle. The tuning indicator circuit may, however, be wired in the opposite manner, with the indicator lamp lighted at all time except during the tuning cycle.

4.2 DETAILED CIRCUIT ANALYSIS.

The following paragraphs describe in detail the theory of operation of the SWR meter circuits, the loading and phasing discriminator circuits, and the loading and phasing servo-amplifier circuits. Throughout the circuit theory outlined in these paragraphs, reference is made to the simplified schematic diagrams provided in this section.

4.2.1 SWR INDICATOR.

Refer to figure 4-2. The SWR indicator circuit consists of a modified Schering bridge, a direct-current voltmeter, and the meter filters and rectifier. One pair of bridge arms is resistive and the other capacitive. The capacitive arms consist of capacitors C701 through C704, and the resistive arms consist of resistors R701 through R710 (ten 10-ohm resistors in parallel) and the impedance seen by the transmitter. The meter rectifier is CR701, and the meter filter consists

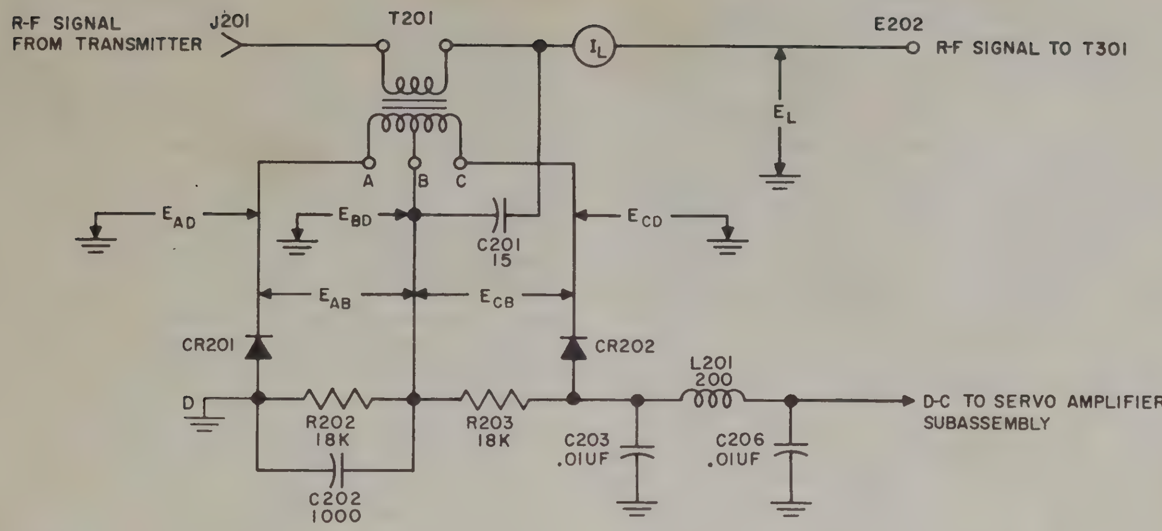


Figure 4-3. Phasing Discriminator, Simplified Schematic Diagram

of L701, L702, R711, R712, C705, and C706. The bridge circuit is balanced when the antenna is tuned to 52 ohms resistive, resulting in zero reading on meter M701. In practical application, meter M701 does not read zero, but reads below the red area when the antenna is tuned properly.

4.2.2 PHASING DISCRIMINATOR.

Refer to figure 4-3. The phasing discriminator circuit produces a d-c output, polarity dependent upon the type of reactance seen by the transmitter. The d-c voltage is produced by rectification of a portion of the r-f signal from the transmitter. The r-f signal from the transmitter is developed across the primary of transformer T201. Transformer T201 consists of a straight section of silver-plated brass rod for the primary and six closely coupled turns of wire for the secondary. The transformer circuit is wire symmetrically around the center of the secondary, and all detail parts are chosen so that transformer T201 is essentially without load. Because of the small amount of current drawn from the primary, the secondary voltage phases may be considered as follows when the transmission line voltage and current are in phase: E_{AB} leads E_{BD} 90 degrees, E_{CB} lags E_{BD} 90 degrees, and E_L and E_{BD} are in phase. The signal induced into the secondary of T201 is proportional to the transmission line current, and the signal coupled through C201 is proportional to the transmission line voltage. Thus, when the transmission line voltage and current are in phase, the phase relationships will be as stated.

When the phase relationships are as outlined in the preceding paragraph, the current from point C, through CR202, through R203, and back to point B is equal to the current from point A, through CR201, through R202, and back to point B. The voltage developed across R203 is equal to the voltage developed across R202 and is of

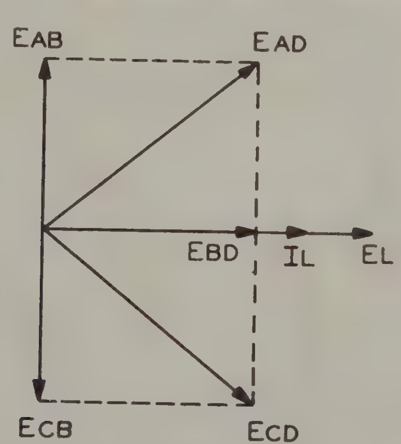


Figure 4-4. Phasing Discriminator, Balanced Condition, Vector Diagram

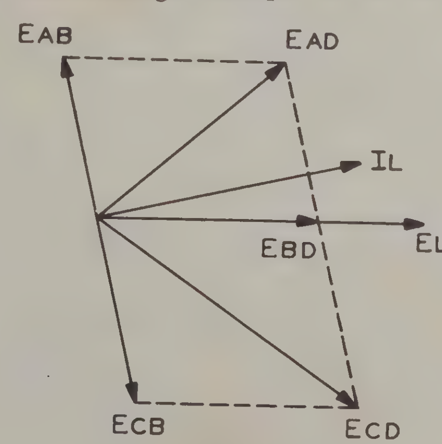


Figure 4-5. Phasing Discriminator, Unbalanced Condition, Vector Diagram

the opposite phase. Cancellation occurs, and the d-c output voltage developed across capacitor C206 is zero.

Assume the transmission line voltage and current are out of phase in such a manner that voltage E_{CD} exceeds voltage E_{AD}. When this phase relationship exists, the voltage across R203 exceeds the voltage across R202, and a net voltage is applied across C206. This net voltage is filtered by C203, L201, and C206 and applied to the servo-amplifier subassembly. A vector analysis of the voltage present in transformer T201 is outlined in the following paragraph.

4.2.2.1 VECTOR ANALYSIS. Refer to the in-phase vector diagram of figure 4-4. When the voltage and current of the transmission line are in phase as shown by vectors E_L and I_L, voltage E_{AB} leads current I_L by exactly 90 degrees, and voltage E_{CB} lags current I_L by exactly 90 degrees. Voltage E_L is divided by capacitors C201 and C202 and appears at the secondary of T201 as voltage E_{BD}. Voltage E_{AD} is the vector sum of voltages E_{AB} and E_{BD}, and voltage E_{CD} is the vector sum of voltages E_{CB} and E_{BD}. The resultant voltages, E_{AD} and E_{CD}, are applied across the two load resistors, R202, and R203 respectively. When in the balanced condition (voltage E_{AD} equal to voltage E_{CD}), the voltages applied across R202 and R203 are equal in amplitude and opposite in polarity. Thus, cancellation occurs, and zero voltage is developed across C206.

Assume that the transmission line current leads the transmission line voltage slightly. The voltages present in the phasing discriminator circuit are illustrated by the out-of-phase vector diagram in figure 4-5. Voltage E_{BD} is still in phase with voltage E_L, and voltage E_{AB} still leads current I_L by 90 degrees. The vector sums of voltage E_{AB} and E_{BD} and voltage E_{CB} and E_{BD} still produce voltages E_{AD} and E_{CD} respectively; however the resultant amplitudes are no longer equal. The current through resistor R203 is now greater than the current through resistor R202, and the resultant d-c voltage developed across C206 has a negative value. If the opposite condition exists in the transmission line, the voltage across R202 becomes dominant, and the resultant output voltage becomes a positive d-c. The d-c output voltage is converted to a 400-cps signal and amplified in the phasing servo-amplifier stages.

4.2.3 LOADING DISCRIMINATOR.

Refer to figure 4-6. The loading discriminator circuit produces a d-c output voltage, polarity dependent upon the amplitude of impedance seen by the transmitter (more or less than 52 ohms). Crystal rectifiers CR203 and CR204 are the loading discriminator rectifiers, which produce rectified d-c voltage proportional to the transmission line current and voltage. Resistor R204 is the load resistor for crystal rectifier CR203. The rectified voltage across R204 is proportional to the voltage between points A and C of T201, and therefore proportional to the primary or transmission line current. Because of transformer action, the rectified voltage developed across R204 is also linear with respect to frequency. Resistor R206 is the load resistor for crystal rectifier CR204. The rectified voltage across R206 depends upon the voltage across resistor R205. Resistor R205 is part of a three-unit voltage divider, consisting of C210, R205, and C211. The

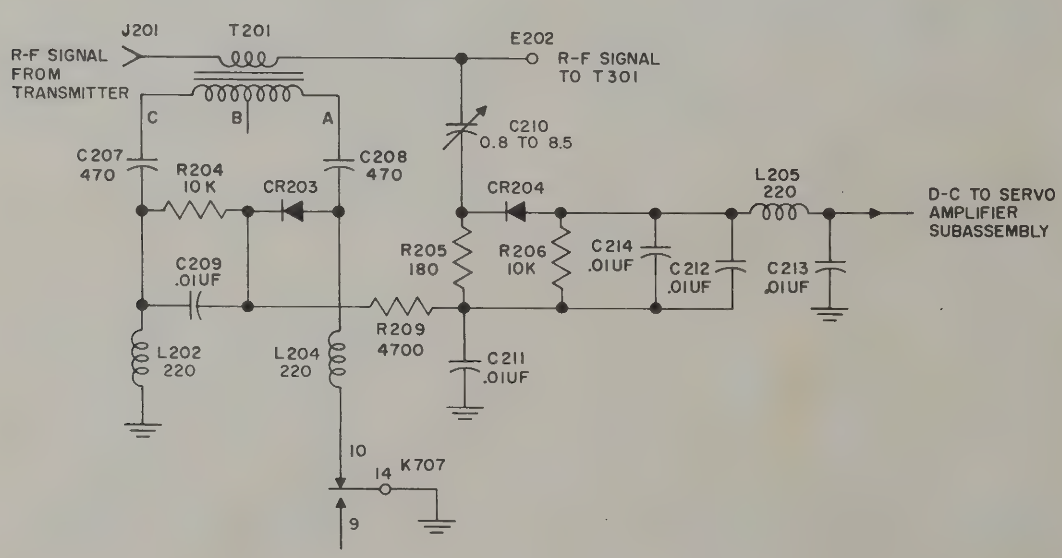


Figure 4-6. Loading Discriminator, Simplified Schematic Diagram

rectified voltage developed across R206 is therefore smaller than, but proportional to, the transmission line voltage. Because the current through resistor R205 will increase in proportion to the frequency, the rectified voltage developed across R206 is also linear with respect to frequency. The rectified voltages developed across load resistors R204 and R206 are of the opposite polarity and, when the impedance seen by the transmitter appears as exactly 52 ohms, will be of the same amplitude. When the transmitter sees exactly 52 ohms, cancellation occurs, and the d-c output developed across C213 is zero.

Assume the antenna resistance appears as more than 52 ohms. In the instance cited, the transmission line current is low and the voltage high. The rectified voltage developed across resistor R204 is low, and the rectified voltage across resistor R206 is high. A negative voltage is produced and applied through L205 to the servo-amplifier subassembly. This voltage is converted into a 400-cps signal, amplified, and used to drive r-f autotransformer T301. If the voltage is negative, as described in the preceding example, r-f autotransformer T301 is driven toward maximum, thus tuning the antenna to 52 ohms.

Following channel selection, it is desirable to unbalance the loading discriminator circuit in order to guarantee a voltage which will initiate the 180L-2 tuning cycle. This unbalance is achieved by ungrounding inductor L204 by opening contacts of relay K707. When relay K707 is energized, inductor L204 is removed from ground and the d-c return for CR203 is removed. The rectified voltage across R204 becomes negligible. The error voltage from the loading discriminator circuit is produced almost entirely by CR204 and is negative in polarity. The r-f autotransformer, T301, is driven toward maximum, and relay K709 is energized. The movement of r-f autotransformer T301 is incidental, the basic purpose being to energize relay K709. The functions and operation of relays K707 and K709 are explained in detail under the control circuit theory.

4.2.4 AVC CIRCUIT.

Refer to figure 4-7. A portion of the r-f signal across transformer T201 is coupled through capacitors C207 and C208 to the avc circuit. Crystal rectifier CR205 is the avc rectifier. The voltage across CR205 depends upon the primary or transmission line current and also upon frequency. As the frequency tends to increase, the voltage across CR205 also increases due to transformer action, and the rectified voltage developed across resistor R207 also increases. The rectified voltage is filtered by the combination of R208, C215, and C216 and applied to the grid circuit of second phasing amplifier V602B for purposes of stabilization. The d-c output of the avc circuit is reduced in amplitude by the voltage divider consisting of R208 and R629. Resistor R629 is selected for optimum avc voltage during alignment. The d-c ground return for the avc circuit is provided by contacts of relay K707. Relay K707 is energized during a portion of the 180L-2 tuning cycle which removes the avc voltage from V602 during this interval. Detailed functioning of relay K707 is included in the control circuit theory.

4.2.5 PHASING SERVO AMPLIFIER.

Refer to figure 4-8. The d-c error voltage from the phasing discriminator circuit is applied to contact 6 of chopper G601 through the audio filter consisting of R611 and C610 and through the lead network consisting of R636, C611 shunted by R612, and the effective resistance to ground of chopper G601. The function of the lead network is to prevent overcorrection or hunting of the reactive circuits. Chopper G601 is energized through the transmitter keying circuits,

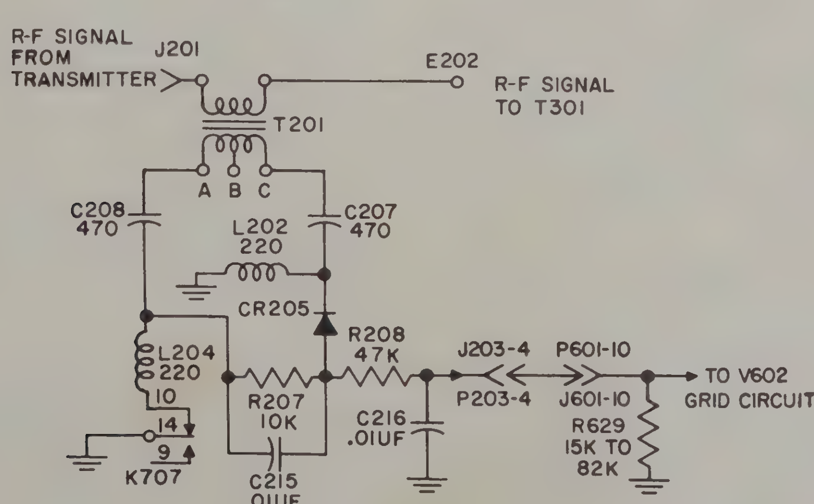


Figure 4-7. AVC Circuit, Simplified Schematic Diagram

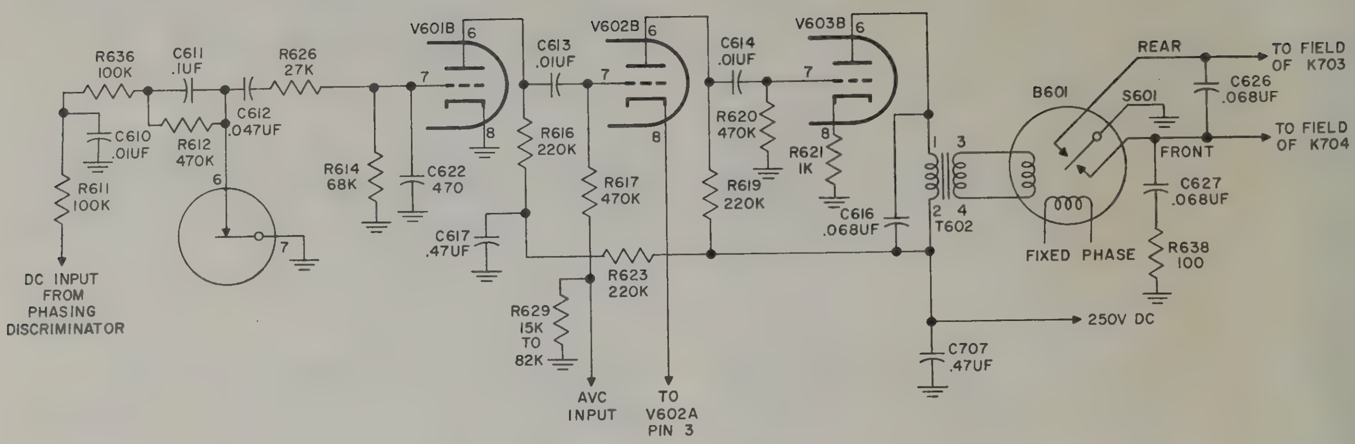


Figure 4-8. Phasing Servo Amplifier, Simplified Schematic Diagram

both during the transmitter channeling cycle and when the transmitter key is depressed. Through the action of chopper G601, the d-c input signal is converted into a 400-cps square-wave signal. This signal is phase dependent upon the polarity of the d-c input voltage and amplitude dependent upon the amplitude of the d-c input voltage. The 400-cps square-wave signal is coupled through capacitor C612 and developed across the grid resistor consisting of R614 and R635 in parallel. Resistor R626 and capacitor C622 comprise an r-f filter which isolates the grid circuit of V601B from spurious r-f signals.

The 400-cps square-wave signal is amplified by V601B and V602B. Both stages are simple voltage amplifiers and are employed merely to increase the amplitude of the square-wave signal. The gain of the second stage, V602B, is controlled slightly by the voltage developed across the secondary of transformer T201 through the avc action discussed in paragraph 4.2.4. The amplified signal is applied to the grid circuit of power output tube V603B. The plate load impedance for V603B is a tuned circuit consisting of the primary of transformer T602 and capacitor C616. The secondary of transformer T602 provides 400-cps input to one phase of motor B601. The operation of B601 is described in the following paragraph.

The 400-cps square-wave signal from transformer T602 is applied across one winding of motor B601. The other winding of B601 is connected through the fixed phase winding of motor B301 to the 115-volt, 400-cps power source. Motor B601 is energized through the transmitter keying circuits whenever the key is depressed or during transmitter channeling cycle. If the antenna reactance appears to the transmitter as capacitive, the phase relationship of the two 400-cps voltages is such that B601 runs in a clockwise direction, which energizes relay K703 through the rear contacts of switch S601. If the antenna reactance appears to the transmitter as inductive, the phase relationship of the two 400-cps voltages is such that B601 runs in the opposite direction, grounding the front contact of S601 and energizing relay K704. Relays K703 and K704, in conjunction with the control circuits, control the application of power to motors B401 and B501 and thereby compensate for reactance seen by the transmitter. The operation of motors B401 and B501 is described in detail in the control circuit theory.

4.2.6 LOADING SERVO AMPLIFIER.

Refer to figure 4-9. The d-c error voltage from the loading discriminator circuit is applied through the audio filter consisting of R632 and C624 to the lead network consisting of R601, C601 shunted by R602, and the effective resistance to ground of chopper G601. Resistors R632 and R633 comprise a voltage divider which reduces the amplitude of the d-c voltage (except during the tuning cycle) to prevent hunting of the correction circuits. During the tuning cycle, resistor R633 and capacitor C624 are removed from ground by contacts of relay K708, and the full amplitude of the d-c voltage is used.

The d-c input voltage is applied to contact 1 of chopper G601. The operation of chopper G601 is identical for the loading servo-amplifier circuit and phasing servo-amplifier circuit.

The 400-cps square-wave signal from the chopper circuit is developed across grid resistor R604. Resistor R625 and capacitor C620 isolate the grid circuit of V601A from spurious r-f signals. The signal is amplified by V601A and V602A which are simple voltage amplifiers employed merely to increase the amplitude of the square-wave signal. The gain of V602A is controlled slightly by the avc action discussed in paragraph 4.2.4. The amplified signal is applied to the

grid of power output tube V603A, and the time constant formed by capacitor C607 and resistor R610 improves the shape of the 400-cps square-wave signal applied. The 400-cps output is developed across the tuned circuit consisting of capacitor C301 and the variable phase winding of motor B301. The coil of relay K709 is in series with the plate of V603A, and when an error signal is present, the 21-volt bias applied to the cathode of V603A is overcome, and the relay is energized due to increased plate current.

The 400-cps voltage developed across the variable phase winding of B301 either leads or lags the fixed phase voltage by 90 degrees depending upon the polarity of the d-c input voltage of chopper G601. The fixed phase winding of motor B301 is energized when the transmitter is keyed and during the transmitter channeling cycle. Motor B301 drives the r-f autotransformer, T301, which compensates for any deviation seen by the transmitter from the optimum of 52 ohms. The direction in which T301 is driven depends upon the amplitude of the impedance error seen by the loading discriminator. If the antenna appears to the transmitter as more than 52 ohms, the d-c input voltage to the loading servo amplifier is negative, and T301 is driven toward maximum. If the antenna appears to the transmitter as less than 52 ohms, the d-c input voltage to the loading servo amplifier is positive, and motor B301 runs in the opposite direction driving T301 toward minimum.

4.3 CONTROL CIRCUITS, GENERAL FUNCTIONING.

The explanations which follow are keyed to a master block diagram of the control circuits, figure 7-5, which is used as an aid in understanding the over-all functioning of these circuits. In addition, simplified block diagrams are provided and are referenced throughout the text. A detailed tracing of the control circuits is covered in paragraph 4.4, but a general understanding should be obtained through use of the information provided here before a detailed analysis is attempted.

4.3.1 GENERAL.

In the following text and figures, repeated reference will be made to several terms which are defined as follows:

a. Phasing system: The phasing system consists of the series tuning elements, motors B401 and B501, and circuits within the variable inductor and variable capacitor subassemblies.

b. Series tuning elements: The series tuning elements are variable inductor L401 and variable capacitor C501.

c. Maximum and minimum of series tuning elements: Maximum L401 means all of the tape is wound on the ceramic drum, and L401 presents maximum inductance to the 180L-2 tuning circuits. Minimum L401 means all of the tape is wound on the metal drum and L401 presents minimum inductance to the 180L-2 tuning circuits. Maximum C501 means the bellows are in the upward position, and C501 presents maximum capacitance to the 180L-2 tuning circuits. Minimum C501 means the bellows are in the downward position, and C501 presents minimum capacitance to the 180L-2 tuning circuits.

d. Maximum and minimum T301: Maximum T301 means the roller is away from the front panel or grounded end, and minimum T301 means the roller is toward the front panel or grounded end.

e. Phasing error: A phasing error is a condition which exists when the phasing discriminator sees a reactive load.

f. Capacitive error: A capacitive error is a phasing error which exists when the phasing discriminator sees a capacitive load.

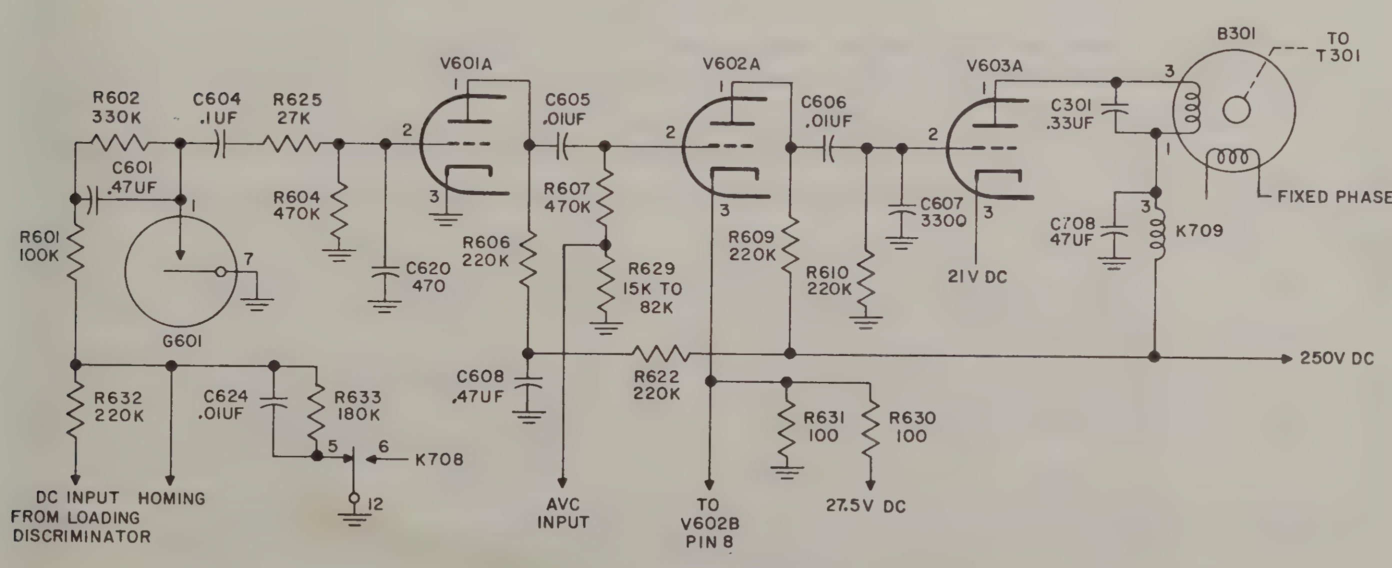


Figure 4-9. Loading Servo Amplifier, Simplified Schematic Diagram

g. Inductive error: An inductive error is a phasing error which exists when the phasing discriminator sees an inductive load.

h. Loading error: A loading error is a condition which exists when the loading discriminator sees an impedance more or less than 52 ohms.

i. Mechanical cycle: The mechanical cycle is a continuous movement of the series tuning elements when driven under control of relays K701, K705, and K706.

j. Home position: When referred to r-f autotransformer, T301, the home position is the center tap position. When referred to variable inductor L401 or variable capacitor C501, the home position means minimum inductance or minimum capacitance respectively.

k. Tuning cycle: The tuning cycle refers to the complete tuning process of the 180L-2 following channel selection.

l. Trim tuning: Trim tuning refers to small changes of T301, L401, or C501 to compensate for minor changes in antenna characteristics. Trim tuning occurs only when the transmitter is keyed.

m. Normally open: Normally open refers to relay contacts which are open when the relay is de-energized.

n. Normally closed: Normally closed refers to relay contacts which are closed when the relay is de-energized.

Because the control circuit operation involves the action of 11 relays, an understanding of the relay functions is necessary for comprehension of the control circuit theory. Table 4-1 outlines the basic functions of each relay, and table 4-2 presents detailed functioning by contact number. Antenna transfer relay K712 and antenna grounding relay K713 are not included in tables 4-1 and 4-2 since they are not part of the control circuit. They will be discussed in the output circuit theory, paragraph 4.5. Tables 4-1 and 4-2 should be referenced throughout the control circuit discussion whenever necessary for clarification.

TABLE 4-1. BASIC RELAY FUNCTIONS

RELAY DESIGNATION	PRIMARY FUNCTION	WHEN ENERGIZED
K701	When de-energized, allows motor B401 to run. When energized, allows motor B501 to run.	Energized during tuning cycle when L401 is either minimum and the phasing system is running toward minimum or six turns from minimum and the phasing system is running toward maximum.
K702	Runs r-f autotransformer T301 toward minimum.	Energized during the T301 homing cycle.
K703	Runs the phasing system motor selected by K701 (B401 or B501) toward maximum.	Energized when the phasing discriminator sees a capacitive phasing error.
K704	Runs the phasing system motor selected by K701 (B401 or B501) toward minimum.	Energized when the phasing discriminator sees an inductive phasing error.
K705	Runs the phasing system motor selected by K701 (B401 or B501) toward maximum.	Energized during the mechanical cycle when both L401 and C501 reach minimum.
K706	Runs the phasing system motor selected by K701 (B401 or B501) toward minimum.	Energized during the mechanical cycle when both L401 and C501 reach maximum.
K707	Starts the automatic keying and homing functions.	Energized following channel selection.
K708	Provides automatic keying during the 180L-2 or 180L-3 tuning cycle.	Energized during the entire 180L-2 or 180L-3 tuning cycle or until K711 opens.
K709	Maintains the automatic keying circuit in conjunction with K708.	Energized when a loading error is seen by the loading discriminator.
K710	Controls shunt capacitor C101.	Energized when L401 and C501 both reach maximum or when T301 reaches maximum.
K711	Opens 27.5-volt d-c circuit if tuning cycle is not completed within 30 to 50 seconds.	Thermal relay begins to heat when transmitter is keyed.

TABLE 4-2. RELAY CONTACT FUNCTIONS

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K701			
1	Stationary	Open.	Connects B401 and B501 to 27.5 volts d-c when series tuning elements are driven toward minimum.
2	Stationary	Connects to armature (terminal 11).	Connects B401 and B501 to 27.5 volts d-c when series tuning elements are driven toward maximum.
3	Coil		Energizes relay when 27.5 volts d-c is applied.
4	Coil		Relay coil ground.
5	Stationary	Connects to armature (terminal 12).	
6 (Not used)			
7	Stationary	Connects to armature (terminal 13).	Ground for B401.
8	Stationary	Open.	Provides ground for B401 and B501.
9	Stationary	Open.	Same as terminal 2.
10	Stationary	Connects to armature (terminal 14).	Same as terminal 1.
11	Movable	Connects to terminal 2.	Controls motor B501.
12	Movable	Connects to terminal 5.	Ground for terminal 5.
13	Movable	Connects to terminal 7.	Selects ground circuit for B401 and B501.
14	Movable	Connects to terminal 10.	Controls motor B401.
RELAY K702			
1	Stationary	Open.	Provides ground for coil of K706 during homing.
2 (Not used)			
3	Coil		Connects to 27.5-volt d-c power source.
4	Coil		Relay coil ground.
5	Stationary	Connects to armature (terminal 12).	Opens capacitor C711 ground circuit.

TABLE 4-2. RELAY CONTACT FUNCTIONS (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K702 (Cont)			
6	Stationary	Open.	Holding circuit for K702.
7	Stationary	Connects to armature (terminal 13).	Applies 27.5 volts d-c to B401 and B501 and to coils of K703, K704, and K705.
8	Stationary	Open.	Applies 27.5 volts d-c to loading servo amplifier when energized.
9 (Not used)			
10	Stationary	Connects to armature (terminal 14).	Ground for resistor R717.
11	Movable	Connects to terminal 2.	Provides ground for K705, K706, K708, and K711.
12	Movable	Connects to terminal 5.	Provides ground for K702 or B301 when S303 is closed.
13	Movable	Connects to terminal 7.	Applies 27.5 volts d-c to terminals 7 or 8.
14	Movable	Connects to terminal 10.	Ground for resistor R717.
RELAY K703			
1	Stationary	Open.	Provides ground for K705, K706, K708, and K711.
2 (Not used)			
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5	Stationary	Connects to armature (terminal 12).	Releases K705 holding circuit to interrupt mechanical cycle.
6 (Not used)			
7	Stationary	Connects to armature (terminal 13).	Provides 27.5 volts d-c for B401 or B501 when K705 is energized; otherwise ground.
8	Stationary	Open.	Provides ground for B401 or B501 when K705 is energized; otherwise 27.5 volts d-c.
9	Stationary	Open.	Provides ground for terminal 12 of K702.

TABLE 4-2. RELAY CONTACT FUNCTIONS (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K703 (Cont)			
10 (Not used)			
11	Movable	Connects to terminal 2.	Provides ground for K705, K706, K708, and K711.
12	Movable	Connects to terminal 5.	Same as terminal 5.
13	Movable	Connects to terminal 7.	Same as terminal 2 of K701.
14	Movable	Connects to terminal 10.	Ground for terminal 9.
RELAY K704			
1	Stationary	Open.	Provides ground for K705, K706, K708, and K711.
2 (Not used)			
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5	Stationary	Connects to armature (terminal 12).	Releases K706 holding circuit to interrupt mechanical cycle.
6	Stationary	Open.	Same as terminal 9 of K703.
7	Stationary	Connects to armature (terminal 13).	Provides 27.5 volts d-c for B401 or B501 when K706 is energized; otherwise ground.
8	Stationary	Open.	Provides ground for B401 or B501 when K706 is energized; otherwise 27.5 volts d-c.
9 (Not used)			
10 (Not used)			
11	Movable	Connects to terminal 2.	Provides ground for K705, K706, K708, and K711.
12	Movable	Connects to terminal 5.	Provides a ground for terminal 6 and releases K706 holding circuit to interrupt mechanical cycle.
13	Movable	Connects to terminal 7.	Same as terminal 1 of K701.
14 (Not used)			

TABLE 4-2. RELAY CONTACT FUNCTIONS (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K705			
1	Stationary	Open.	Provides 27.5 volts d-c for B401 and B501.
2	Stationary	Connects to armature (terminal 11).	Provides ground for B401 and B501.
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5 (Not used)			
6	Stationary	Open.	Holding circuit for K705.
7	Stationary	Connects to armature (terminal 13).	Releases K706 holding circuit at minimum C501.
8	Stationary	Open.	Same as terminal 9 of K703.
9	Stationary	Open.	Same as terminal 2.
10	Stationary	Connects to armature (terminal 14).	Same as terminal 1.
11	Movable	Connects to terminal 2.	Same as terminal 7 of K703.
12	Movable	Connects to terminal 5.	Same as terminal 6.
13	Movable	Connects to terminal 7.	Provides ground for K705, K706, K708, and K711.
14	Movable	Connects to terminal 10.	Same as terminal 8 of K704.
RELAY K706			
1	Stationary	Open.	Provides 27.5 volts d-c for B401 and B501 with K705 de-energized.
2	Stationary	Connects to armature (terminal 11).	Provide ground for B401 and B501.
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5 (Not used)			
6	Stationary	Open.	Holding circuit for K706.

TABLE 4-2. RELAY CONTACT FUNCTIONS (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K706 (Cont)			
7	Stationary	Connects to armature (terminal 13).	Releases K707 holding circuit when r-f appears at input.
8	Stationary	Open.	Same as terminal 9 of K703.
9	Stationary	Open.	Same as terminal 2.
10	Stationary	Connects to armature (terminal 14).	Provides 27.5 volts d-c for B401 and B501.
11	Movable	Connects to terminal 2.	Same as terminal 7 of K704.
12	Movable	Connects to terminal 5.	Same as terminal 6.
13	Movable	Connects to terminal 7.	Provide ground for terminal 7 or 8.
14	Movable	Connects to terminal 10.	Same as terminal 8 of K703.
RELAY K707			
1	Stationary	Open.	Connects breaking capacitor C711 to B301.
2	Stationary	Connects to armature (terminal 11).	Interrupts homing voltage.
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5 (Not used)			
6	Stationary	Open.	Holding circuit for K707.
7	Stationary	Connects to armature (terminal 13).	Provides holding circuit for K708 and K711.
8	Stationary	Open.	Provides ground for K708 and K711.
9	Stationary	Open.	Provides ground for K702.
10	Stationary	Connects to armature (terminal 14).	Releases K710 holding circuit and opens ground for unbalancing loading discriminator.
11	Movable	Connects to terminal 2.	Same as terminal 2.
12	Movable	Connects to terminal 5.	Same as terminal 6.
13	Movable	Connects to terminal 7.	Provides ground for K708 and K711.
14	Movable	Connects to terminal 10.	Provides ground for terminals 9 and 10.

TABLE 4-2. RELAY CONTACT FUNCTION (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K708			
1	Stationary	Open.	External tuning indication.
2	Stationary	Connects to armature (terminal 11).	External tuning indication.
3	Coil		Connects to 27.5 volts d-c.
4	Coil		Relay coil ground.
5	Stationary	Connects to armature (terminal 12).	Provides ground for R628 to reduce sensitivity of loading servo amplifier.
6	Stationary	Open.	Provides ground for reducing transmitter power output.
7 (Not used)			
8	Stationary	Open.	Provides ground for terminal 13.
9	Stationary	Open.	Provides ground for K705, K706, K708, and K711.
10 (Not used)			
11	Movable	Connects to terminal 2.	External tuning indication.
12	Movable	Connects to terminal 5.	Provides ground for terminals 5 and 6.
13	Movable	Connects to terminal 7.	Provides ground for K705, K706, K708, and K711 and for the transmitter keying circuits.
14	Movable	Connects to terminal 10.	Provides holding ground for K708 and K711.
RELAY K709			
3	Coil		Connects to plate circuit of V603A.
4	Coil		Connects to B-plus line.
8	Stationary	Open.	Provides ground for K705, K706, K708, and K711.
9	Movable	Open.	Provides ground for terminal 9.

TABLE 4-2. RELAY CONTACT FUNCTIONS (Cont)

TERMINAL	CONTACT TYPE	DE-ENERGIZED POSITION	FUNCTION
RELAY K710			
1	Stationary	Connects to armature.	Shorts K710 coil when de-energized.
2	Coil		Connects to 27.5 volts d-c.
3	Coil		Relay coil ground.
4	Stationary	Open.	Provides holding ground for K710.
RELAY K711			
2	Heater		Heater ground.
3	Heater		Connects to 27.5 volts d-c.
5	Bimetal	Connects to terminal 7.	Provides 27.5 volts d-c to terminal 7.
7	Stationary	Connects to terminal 5.	Provides 27.5 volts d-c to control circuits.

Table 4-3 lists each switch employed in Automatic Antenna Tuner 180L-2 and the functions of each. Table 4-3 should be referenced throughout the control circuit discussion whenever necessary for clarification.

TABLE 4-3. SWITCH FUNCTIONS

DESIGNATION	FUNCTION
S303	Operated by motor B301; provides circuit for breaking B301 or holding K702; closed when T301 is above center tap.
S304	Operated by motor B301; provides ground for K702 and K710 when T301 is at maximum.
S401A	Operated by motor B401; opens B401 ground circuit when L401 reaches maximum.
S401B	Operated by motor B401; energizes K701 when L401 reaches minimum (going toward minimum) and when L401 reaches six turns from minimum (going toward maximum).
S402A	Operated by motor B401; provides ground for K710 when L401 is at maximum and provides ground for K705 when L401 and C501 are both at minimum.
S402B	Operated by motor B401; opens holding circuit for K705 and provides ground for K706 when L401 is at maximum.
S501	Operated by motor B501; opens ground circuit to B501 and 27.5-volt d-c circuit to K701 when C501 reaches maximum.
S502	Operated by motor B501; opens ground circuit to B501 when C501 reaches minimum and provides a ground circuit for K705 when both L401 and C501 reach minimum.
S601	Operated by motor B601; provides ground for either K703 or K704, depending upon the type of phasing error.
S703	Closes at temperatures below approximately -30°C (-22°F); heats motor B301 when closed.

4.3.1.1 SEQUENCE OF OPERATION. Refer to figure 4-10. The general operations that are involved in the 180L-2 control circuits during the channeling cycle are outlined in steps a through f of this paragraph. Steps a through f outline the general operations in the correct time sequence. These operations are further described, through use of block diagrams, in paragraphs 4.3.2 through 4.3.6.

a. The radio set control of the associated transceiver is rotated, providing information to the 180L-2 control circuits. If the 180L-2 is connected for radio silence operation, the retune information is not provided until the telegraph key or microphone push-to-talk button is depressed.

b. The 180L-2 control circuits provide automatic keying for the transmitter.

c. The r-f autotransformer runs to the home position (center tap) which starts the phasing system in the home direction (toward minimum values of inductance and capacitance).

d. The phasing system is operated through a mechanical cycle which is stopped when the phasing discriminator analyzes the particular antenna reactance. The phasing discriminator drives the phasing system to the tuned position. If the phasing system fails to find a tuning point, the shunt capacitance is connected into the circuit, and the phasing system recycles.

e. The r-f autotransformer is driven under control of the loading discriminator until the antenna is resonated to 52 ohms resistive. If the r-f autotransformer fails to find a tuning point, the shunt capacitance is connected into the circuit, and the phasing system and r-f autotransformer recycle.

f. The automatic keying of the transmitter is interrupted, and the tuning cycle is complete.

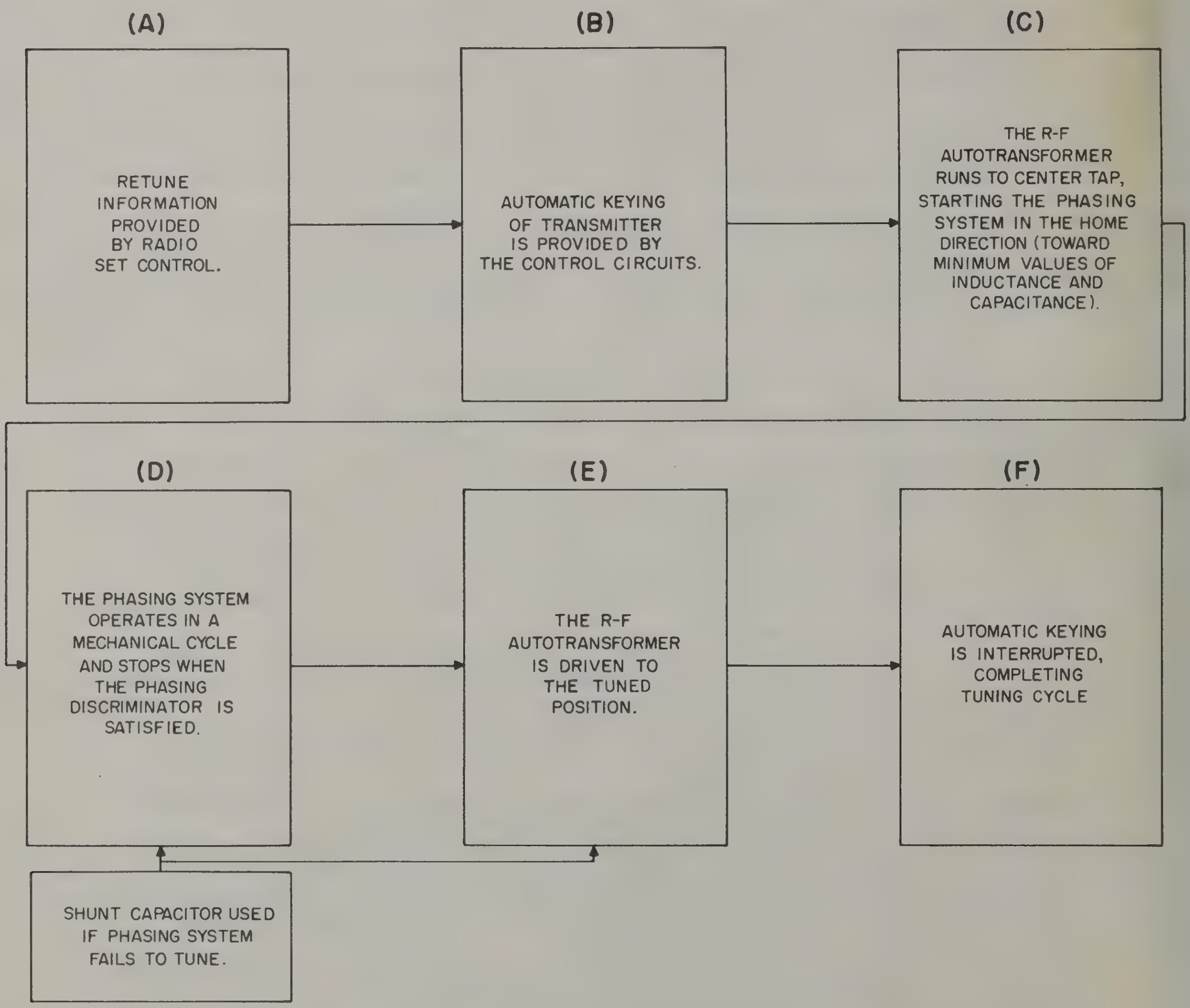


Figure 4-10. Control Circuits, Sequence of Operation

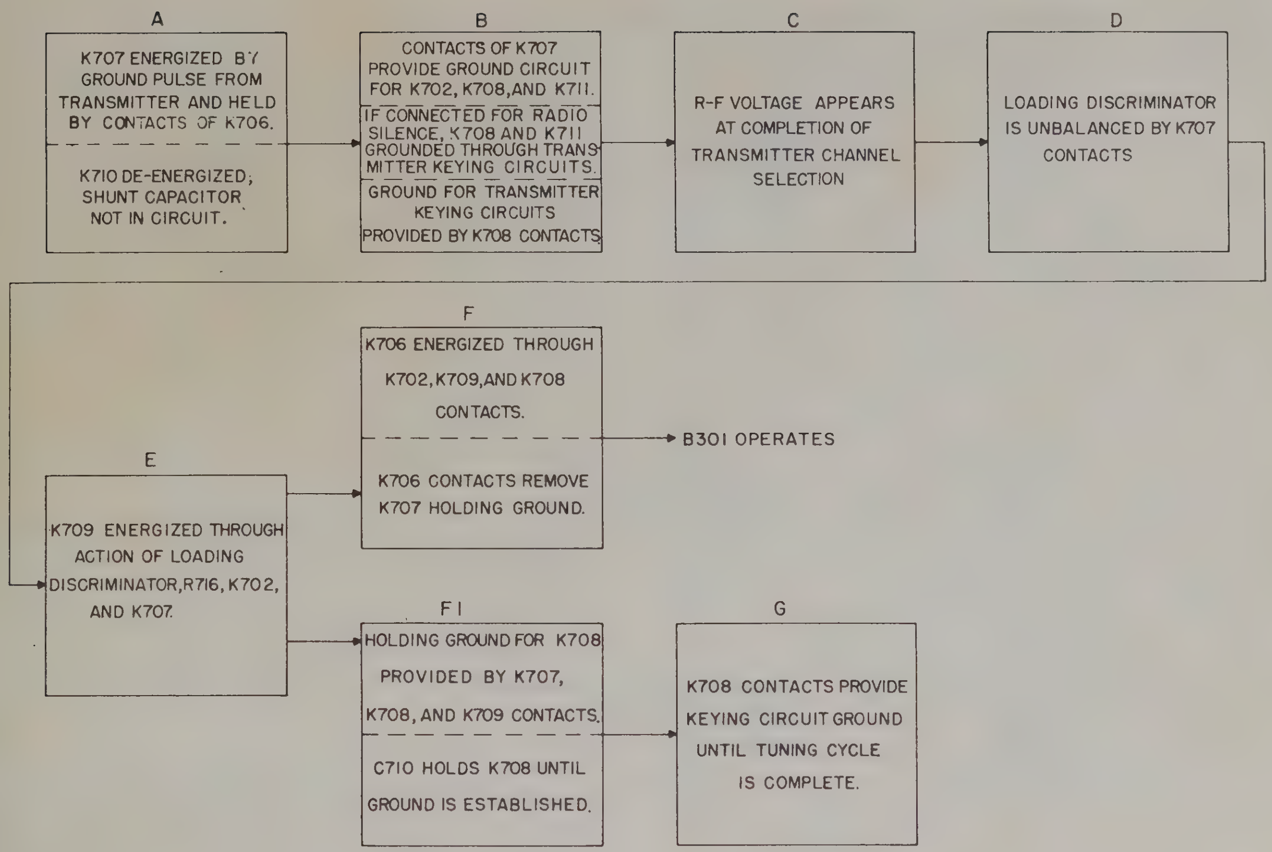


Figure 4-11. Automatic Keying Circuits, Sequence of Operation

4.3.2 AUTOMATIC KEYING.

The general functioning of the automatic keying circuit is noted in blocks 1 through 8 of the master block diagram, figure 7-5. Refer to figures 4-11, 7-5, and 7-6 throughout the following discussion.

a. Circuits within the associated transceiver provide a ground pulse which energizes retune relay K707. Retune relay K707 is held by normally closed contacts of maximum reverse relay K706. Relay K710 is de-energized; therefore, shunt capacitor C101 is not in the circuit.

b. Contacts of retune relay K707 provide a ground circuit and energize homing relay K702, automatic keying relay K708, and time-delay relay K711. If the 180L-2 is connected for radio silence operation, K708 and K711 remain de-energized until the transmitter is manually keyed. Automatic keying relay K708 provides a ground for the transmitter keying circuits.

c. The r-f voltage from the transmitter is applied upon completion of the transceiver channeling cycle.

d. The loading discriminator is unbalanced through the action of relay K707, producing a d-c output voltage.

e. Loading error relay K709 is energized through operation of the loading discriminator and loading servo-amplifier circuits. Positive action of K709 is assured by resistor R716. Resistor R716 is shunted from the plate circuit of V603A to ground through contacts of K702 and K707. The bleeder current through R716 adds to the V603A plate current, thereby increasing the total current through the coil of K709. When K702 is de-energized during automatic homing, resistor R717 replaces resistor R716, holding relay K709.

f. Maximum reverse relay K706 is energized through contacts of K702, K709, and K708. Contacts of K706 remove the holding ground for K707, and K707 is de-energized. A holding ground is provided for K708 through normally closed contacts of K707, through normally open contacts of K708, and through normally open contacts of K709. Capacitor C710 provides a ground for K708 until this ground is established.

g. Contacts of K708 provide a ground for the transmitter keying circuits until the 180L-2 tuning cycle is complete.

4.3.3 AUTOMATIC HOMING.

The general functioning of the automatic homing circuit is noted in blocks 9 through 14 of the master block diagram, figure 7-5. Refer to figures 4-12, 7-5, and 7-6 throughout the following discussion.

The automatic homing function of Automatic Antenna Tuner 180L-2 achieves two results: driving T301 to

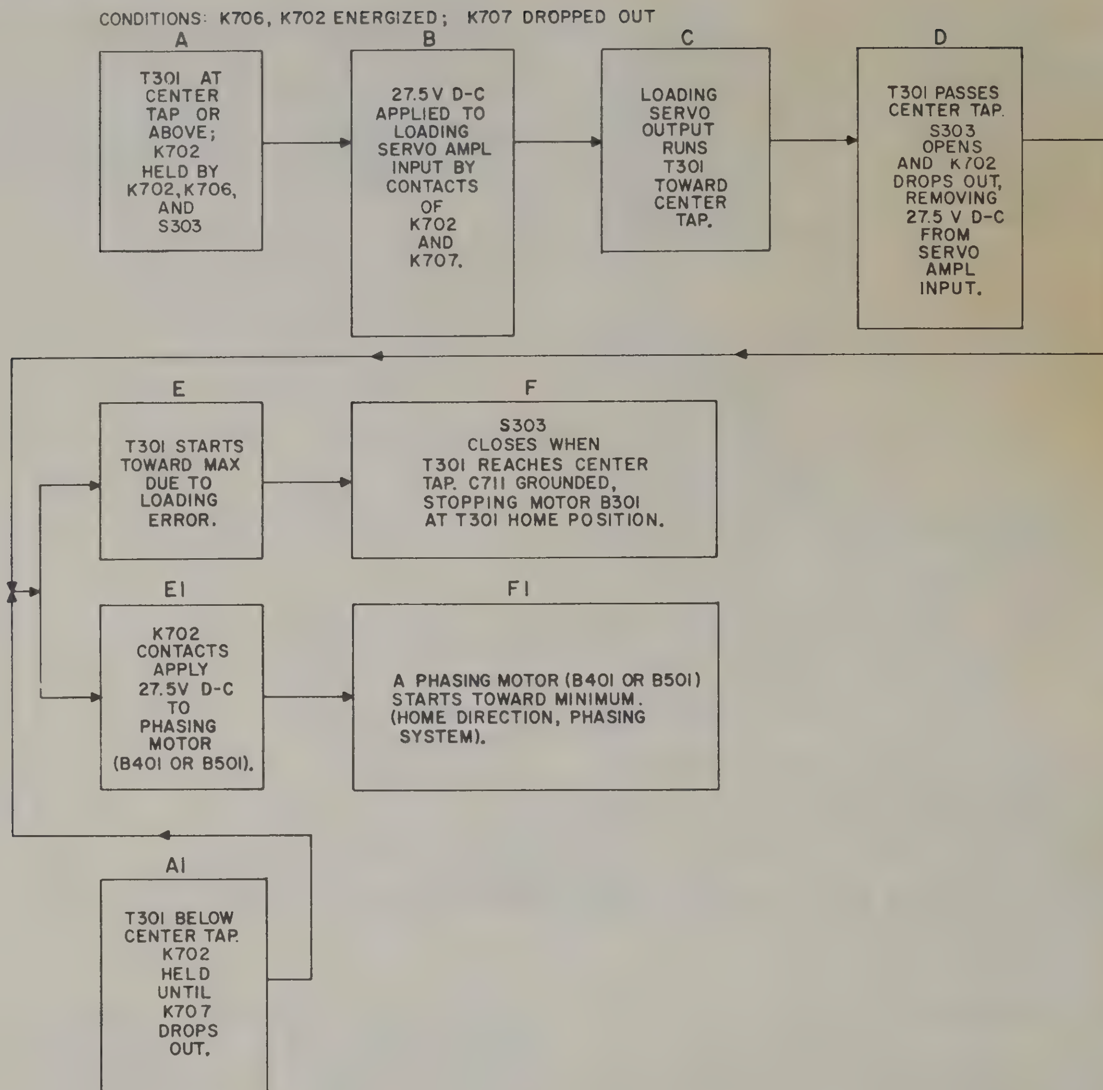


Figure 4-12. Automatic Homing Circuits, Sequence of Operation

center tap and stopping B301, and starting the phasing system motors (B401 and B501) toward minimum values. It is apparent, from examination of figure 4-12, that two possible starting points exist. A longer sequence results when the homing operation begins with the r-f autotransformer, T301, at or above the center tap position. Steps a through g describe the sequence of operation of both the long- and short-time sequences.

a. Relays K702 and K706 are energized, and relay K707 is de-energized. (Refer to paragraph 4.3.6 and figure 4-11.) Relay K702 is held by contacts of K702, S303, and K706. The r-f autotransformer is above center tap and switch S303 is closed.

b. The loading servo-amplifier circuit is energized with 27.5 volts d-c through contacts of K707 and K702.

c. The loading servo-amplifier output energizes motor B301, driving T301 toward the center tap position.

d. The r-f autotransformer, T301, passes center tap, switch S303 opens, and relay K702 is de-energized. The 27.5-volt d-c input to the loading servo amplifier is removed by contact of K702.

e. The r-f autotransformer, T301, starts toward maximum due to the loading error and contacts of K702 apply 27.5 volts d-c to the phasing system motor selected by K701 (B401 or B501).

f. Switch S303 again closes when T301 reaches center tap (going toward maximum). Capacitor C711 is shunted from the plate of the loading servo-amplifier stage V603A to ground, thus de-energizing motor B301 and holding T301 at center tap. The phasing system motor selected by K701 drives L401 or C501 toward minimum (home direction).

g. In the shorter sequence of operation, with T301 below the center tap position, the sequence begins with block A1 of figure 4-12. Switch S303 is open, and relay K702 is de-energized after K707 drops out. Operation now is identical with steps e and f of this paragraph and blocks E, E1, F, and F1 of figure 4-12.

4.3.4 MECHANICAL CYCLE.

The series tuning elements of the phasing system are set in motion toward the home position (minimum) at completion of the automatic homing sequence as described in paragraph 4.3.3. The output of the phasing discriminator and phasing servo-amplifier circuits act to bring the antenna to resonance immediately after the r-f signal is applied from the transmitter. In some cases, the phasing discriminator may not see a resonant point with the series tuning elements running toward minimum. Also, the shunt capacitance (C101) may be required before the series tuning elements can properly tune the antenna. To assure that the series tuning elements may at all times be able to resonate the antenna properly, a system of interim operation is provided. This interim operation conducts the series tuning elements through a specified excursion from any starting point and switches in the shunt capacitance as the elements reach their maximum position. This excursion is continued until the phasing discriminator and phasing servo-amplifier circuits are able to resonate the antenna correctly. The excursion of the series tuning elements is referred to as the mechanical cycle.

The starting point of the mechanical cycle may fall at any point between maximum and minimum capacitance or inductance, but will always run the series tuning elements toward minimum values first because of the automatic homing function. After starting toward minimum through the automatic homing circuits, the mechanical cycle is instigated, and the series tuning elements are driven through sufficient steps for the phasing discriminator to see a resonant point. If this resonant point is not found throughout the first phase of the mechanical cycle, the shunt capacitance is switched into the circuit, and the mechanical cycle is repeated. The shunt capacitance is switched into the circuit when the mechanical cycle is at a point corresponding to maximum inductance and capacitance (series tuning elements at maximum). The exact point where the shunt capacitance is employed is described in detail in paragraph 4.3.4.3.

4.3.4.1 SEQUENCE OF OPERATION. The sequence of operation of the mechanical cycle is illustrated in figure 4-13. Four relays are employed to complete the mechanical cycle. Maximum reverse relay K706 drives the series tuning elements toward minimum when energized. Minimum reverse relay K705 drives the series tuning elements toward maximum when energized. Coil capacitor relay K701 selects the correct phasing system motor; when de-energized, motor B401 is allowed to run; when energized, motor B501 is allowed to run. Shunt capacitor relay K710 switches the shunt capacitance into the circuit when the series tuning elements reach maximum. For purposes of the discussion outline in steps a through f, it is assumed that the 180L-2 cannot tune. In actual operation, however, the phasing discriminator and phasing servo-amplifier circuits would find a resonant point and stop the series tuning elements before the mechanical cycle was complete. Also, for explanatory purposes, the mechanical cycle is assumed to start at point a of figure 4-13. It should be understood, however, that the mechanical cycle may start at any point and end at any point, depending upon the frequency of the previous channel and the frequency of the desired channel.

a. Starting at point a, relay K706 is energized, and relays K701, K705, and K710 are de-energized. Variable inductor L401 is driven to minimum to complete operation number 1. When position B is reached, relay K701 is energized.

b. Starting at point b, relays K706 and K701 are energized, and relays K705 and K710 are de-energized. Variable capacitor C501 is driven to minimum to complete operation number 2. When position C is reached, relay K705 is energized, and relays K701 and K706 are de-energized.

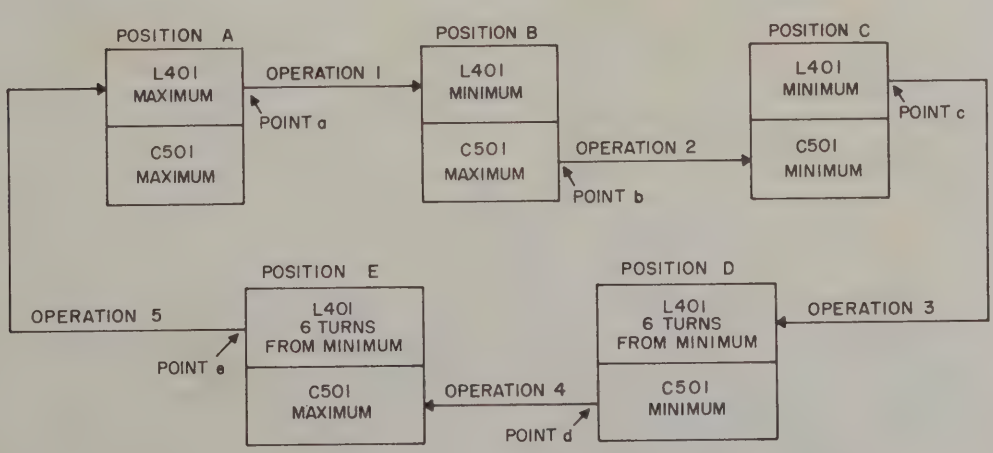


Figure 4-13. Mechanical Cycle, Sequence of Operation

c. Starting at point c, relay K705 is energized, and relays K701, K706, and K710 are de-energized. Variable inductor L401 is driven to six turns from minimum to complete operation number 3. When position D is reached, relay K701 is energized.

d. Starting at point d, relays K705 and K701 are energized, and relays K706 and K710 are de-energized. Variable capacitor C501 is driven to maximum to complete operation number 4. When position E is reached, relay K701 is de-energized.

e. Starting at point e, relay K705 is energized, and relays K701, K706, and K710 are de-energized. Variable inductor L401 is driven to maximum to complete operation number 5. When position A is reached, relays K710 and K706 are energized, and relay K705 is de-energized.

f. Shunt capacitor C101 is switched into the circuit by K710 at position A, and relay K706 restarts the mechanical cycle. The operation is identical to steps a through e of this paragraph with the exception that C101 is now in the circuit and relay K710 remains energized.

g. At some point within the mechanical cycle, the phasing discriminator will find a tuning point and the mechanical cycle is stopped.

4.3.4.2 PHASING ERROR ANALYSIS. Figure 4-14 illustrates the output of the phasing discriminator throughout the range of the mechanical cycle. The two curves are derived from a typical discriminator "S" curve and are slightly exaggerated for purposes of explanation. Capital letters A through F refer to areas of phasing error. The boundaries of each phasing error are indicated by capital letters and numerals. The boundaries of phasing error A, for example, are A1 and A2. A total of six possible phasing error cases exist in the 180L-2, therefore each is covered by a separate capital letter. The numerals and directional arrows in figure 4-13 refer to the direction of movement of the mechanical cycle (toward minimum or maximum) at a particular time. Actual tuning points are indicated by letter-numeral combinations in figure 4-14 (T1 and T2). False tuning points are FT1 and FT2. Paragraphs 4.3.4.2.1 through 4.3.4.2.5 describe the operation of the phasing circuits with reference to figures 4-14, 4-15, and 7-5.

NOTE

The discussion in paragraphs 4.3.4.2.1 through 4.3.4.2.5 assumes that shunt capacitor C101 is not needed to complete the tuning cycle. Paragraph 4.3.4.3 describes the action of shunt capacitor C101.

4.3.4.2.1 CAPACITIVE PHASING ERROR, CASE A. Steps a through e describe the action of the phasing discriminator and series tuning elements for the most complicated tuning case.

a. A capacitive phasing error is seen by the phasing discriminator, and relay K706 has started the series tuning elements toward minimum in area A. Refer to numeral-arrow 1 of figure 4-14.

b. When point A2 is reached, relay K706 forces the series tuning elements past false tuning point FT1. Relay K704 is energized and relay K706 is de-energized, the series tuning elements continue toward minimum under control of K704, as indicated by numeral-arrow 2.

c. The series tuning elements reach minimum, energizing relay K705. The series tuning elements are driven toward maximum under control of K705 as indicated by numeral-arrow 3.

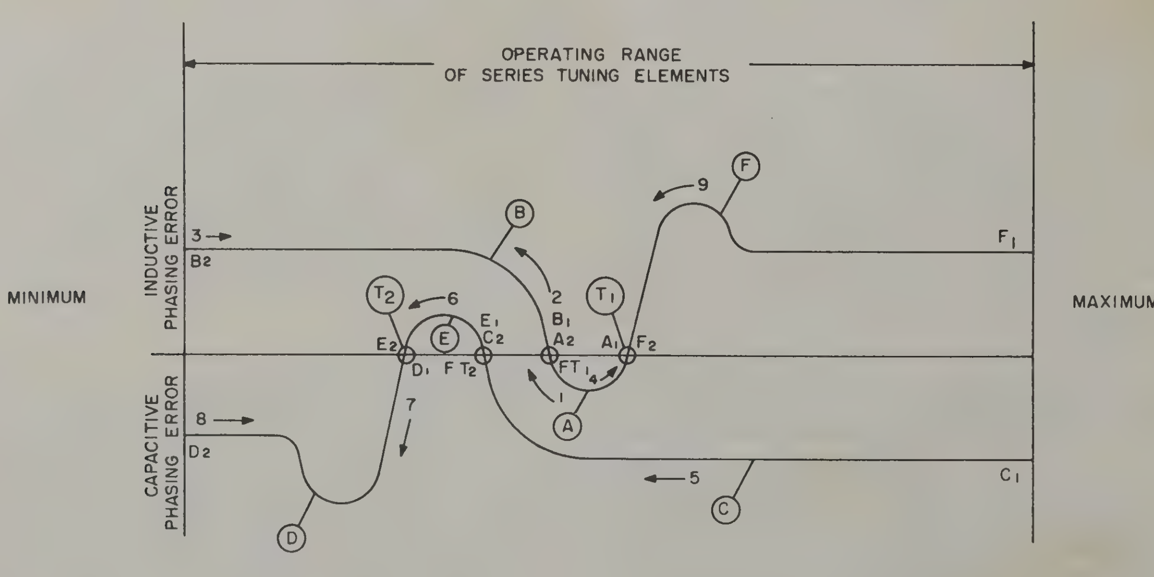


Figure 4-14. Typical Phasing Errors as Seen By Phasing Discriminator, Graphical Analysis

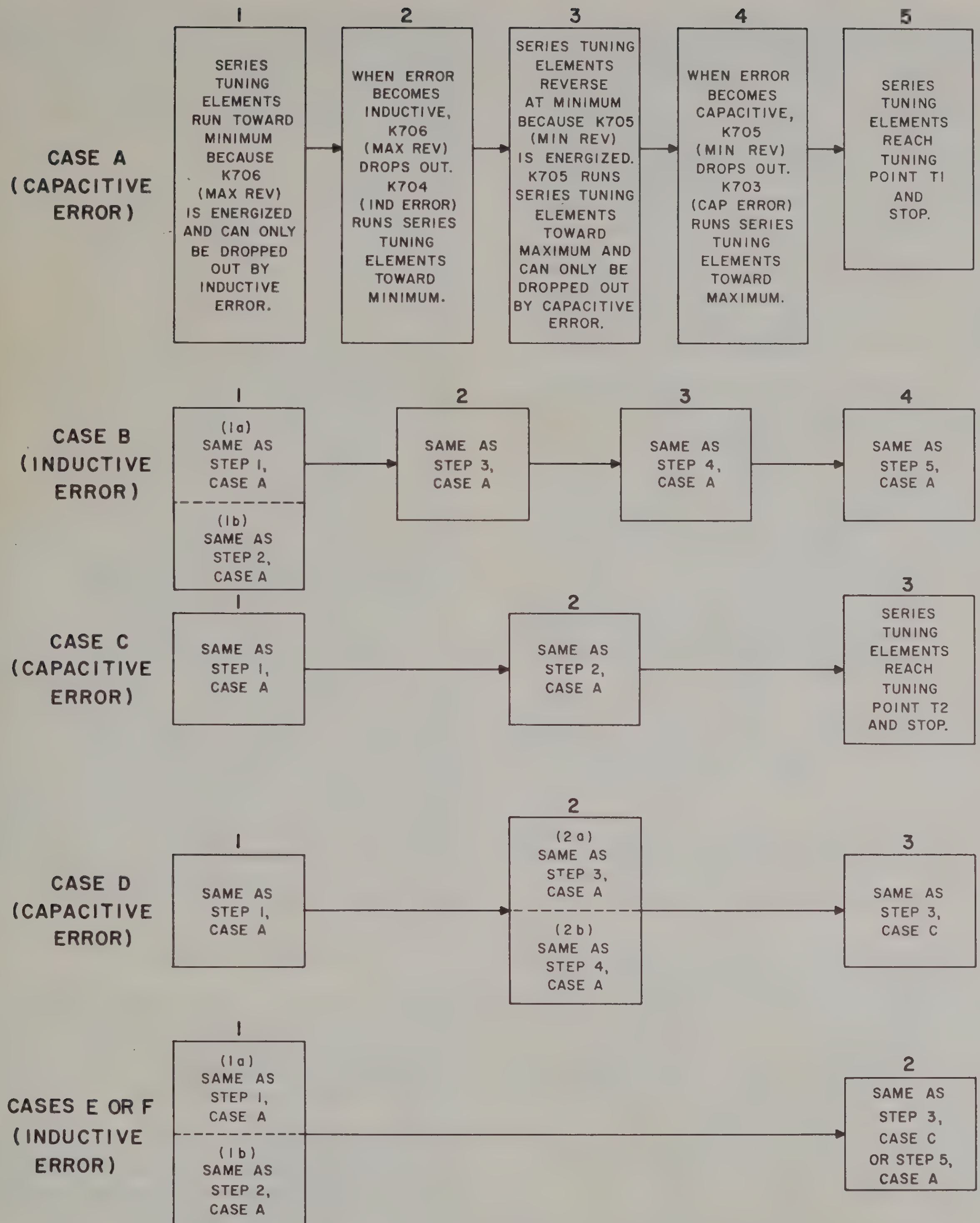


Figure 4-15. Typical Phasing Errors, Sequence of Operation

d. When point A2 is reached, relay K705 forces the series tuning elements past false tuning point FT1. Relay K703 is energized and relay K705 is de-energized. The series tuning elements continue toward maximum under control of K703, as indicated by numeral-arrow 4.

e. The series tuning elements reach tuning point T1, and the phasing discriminator is satisfied. The tuning cycle of L401 and C501 is complete.

4.3.4.2.2 INDUCTIVE PHASING ERROR, CASE B.

a. An inductive phasing error is seen by the phasing discriminator, and relay K706 has started the series tuning elements toward minimum in area B. Because the error is inductive, relay K704 is energized and relay K706 is de-energized. The series tuning elements continue toward minimum as shown by numeral-arrow 2 of figure 4-14.

b. Same as step c, paragraph 4.3.4.2.1.
c. Same as step d, paragraph 4.3.4.2.1.
d. Same as step e, paragraph 4.3.4.2.1.

4.3.4.2.3 CAPACITIVE PHASING ERROR, CASE C.

a. A capacitive phasing error is seen by the phasing discriminator, and relay K706 has started the series tuning elements toward minimum in area C. Refer to numeral-arrow 5 of figure 4-14.
b. When point C2 is reached, relay K706 forces the series tuning elements past false tuning point FT2. Relay K704 is energized and K706 is de-energized. The series tuning elements continue toward minimum under control of K704, as indicated by numeral-arrow 6.
c. The series tuning elements reach tuning point T2, and the phasing discriminator is satisfied. The tuning cycle of L401 and C501 is complete.

4.3.4.2.4 CAPACITIVE PHASING ERROR, CASE D.

a. A capacitive phasing error is seen by the phasing discriminator, and relay K706 has started the series tuning elements toward minimum in area D. Refer to numeral-arrow 7 of figure 4-14.
b. The series tuning elements reach minimum, energizing relay K705 and de-energizing relay K706. The series tuning elements are reversed and driven toward maximum by relay K705.
c. The capacitive error persists and relay K703 is energized, de-energizing relay K705. The series tuning elements are driven toward tuning point T2 under control of relay K703 as indicated by numeral-arrow 8.
d. The series tuning elements reach tuning point T2, and the phasing discriminator is satisfied. The tuning cycle of L401 and C501 is complete.

4.3.4.2.5 INDUCTIVE PHASING ERROR, CASE E OR F.

a. An inductive phasing error is seen by the phasing discriminator, and relay K706 has started the series tuning elements toward minimum in area E or F. Refer to numeral-arrow 6 or 9.
b. The inductive error persists and relay K704 is energized, de-energizing relay K706. The series tuning elements are driven toward tuning point T1 or T2 under control of relay K704.
c. The series tuning elements reach tuning point T1 or T2, and the phasing discriminator is satisfied. The tuning cycle of L401 and C501 is complete.

4.3.4.3 ANTENNA SHUNT CAPACITANCE. If the antenna reactance has not been resonated by the time the series tuning elements reach their maximum positions, the mechanical cycle will switch shunt capacitor C101 into the circuit. Shunt capacitor C101 cannot be in the circuit when the phasing system starts to seek resonance because of each new channel selection, K707 operates to drop out K710 and disconnect C101. Since the series tuning elements start their cycle in the minimum direction, they are allowed to complete a minimum to maximum cycle and tune, if possible, without the shunt capacitance. If the series tuning elements complete this cycle and are unable to tune, the need for the shunt capacitance is determined, and relay K710 is energized thus placing the shunt capacitance in the circuit. The effect of introducing the shunt capacitance into the circuit is to move the phasing error curve shown in figure 4-14 into a useful area.

The shunt capacitance also may be brought into the circuit if the loading discriminator sees an impedance error beyond the range of the r-f autotransformer. This will be discussed in detail in paragraph 4.3.5.

4.3.5 LOADING CYCLE.

When the mechanical cycle is completed, the loading cycle is started. If the loading discriminator sees an antenna load of less than 52 ohms, a positive d-c voltage is applied to the loading servo amplifier, and the output drives motor B301 and r-f autotransformer T301 toward minimum. If the loading discriminator sees an antenna load of more than 52 ohms, a negative d-c voltage is applied to the loading servo amplifier, and the output drives motor B301 and r-f autotransformer T301 toward maximum. These actions are discussed in detail in paragraphs 4.2.3 and 4.2.6.

If the antenna impedance is too high at the maximum point of the r-f autotransformer, switch S304 operates and provides a ground for relay K710. Relay K710 is energized, and the antenna shunt capacitance is connected into the circuit. At the same instant, the homing function is started by switch S304, and r-f autotransformer T301 is driven to center tap, and the series tuning elements are driven toward minimum. The mechanical cycle is completed when the phasing discriminator is satisfied, and the r-f autotransformer is driven to the tuned position under control of the loading discriminator.

4.3.6 UNKEYING OF TRANSMITTER.

When the antenna is tuned properly to 52 ohms resistive, all of the 180L-2 control circuit relays are de-energized. The transmitter keying ground is removed by relay K708, and the transceiver is ready for operation on the newly selected channel.

When the transmitter is in actual operation, additional fine tuning of the antenna is constantly provided under control of the phasing and loading discriminators. The automatic keying and homing functions are not involved in this operation since K707 is not energized unless the channel selector switch on the radio set control of the associated transceiver is rotated. However, at any time r-f appears in the 180L-2 input, relay K703 or relay K704 may be energized. These relays, in turn, will keep the series tuning elements in resonance. Also, the r-f autotransformer is adjusted to compensate for small antenna impedance changes.

4.4 CONTROL CIRCUITS, DETAILED FUNCTIONING.

The following discussion is a detailed tracing of the control circuits covered in the preceding text. Motor

control and protection circuits are traced first. Thereafter, the circuits are traced in the sequence used to discuss their general theory. Simplified schematic diagrams are provided and referenced throughout the following paragraphs. In addition, reference should be made to the main schematics in section VII and to the definitions and relay and switch function tables in paragraph 4.3.1.

4.4.1 MOTOR CONTROL CIRCUITS.

The motor control circuits cause motors B401 and B501 to operate in one of two directions, driving variable inductor L401 and variable capacitor C501 toward either maximum or minimum, depending upon the positions of control circuit relays. Steps a through e outline the sequence of operation of motors B401 and B501 and the control circuit relays involved. Refer to figure 4-16 throughout the following discussion.

NOTE

The discussion in steps a through d assumes that terminal 2 and 9 of relays K705 and K706 are grounded directly. Actually, these terminals are grounded through contacts of limit switches S401A, S501, and S502.

min
max

a. Assume a capacitive error is seen by the phasing discriminator. Relay K703 is energized through contacts of switch S601, and relays K701, K704, K705, and K706 are de-energized. The black B401 lead is connected to 27.5 volts d-c through J401-4, P401-4, K703-13, K703-8, K706-14, and K706-10. The red B401 lead is connected to ground through J401-11, P401-11, K701-14, K701-10, K704-13, K704-7, K706-11, and K706-2. When connected in this manner, motor B401 drives variable inductor L401 toward maximum.

b. Assume an inductive error is seen by the phasing discriminator. Relay K704 is energized through contacts of switch S601, and relays K701, K703, K705, and K706 are de-energized. The red B401 lead is connected to 27.5 volts d-c through J401-11, P401-11, K701-14, K701-10, K704-13, K704-8, K705-14, and K705-10. The black B401 lead is connected to ground through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-2. When connected in this manner, motor B401 drives variable inductor L401 toward minimum.

c. Assume the series tuning elements reach minimum. Relay K705 is energized and relays K701, K703, K704, and K706 are de-energized. The black B401 lead is connected to 27.5 volts d-c through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-1. The red B401 lead is connected to ground through J401-11, P401-11, K701-14, K701-10,

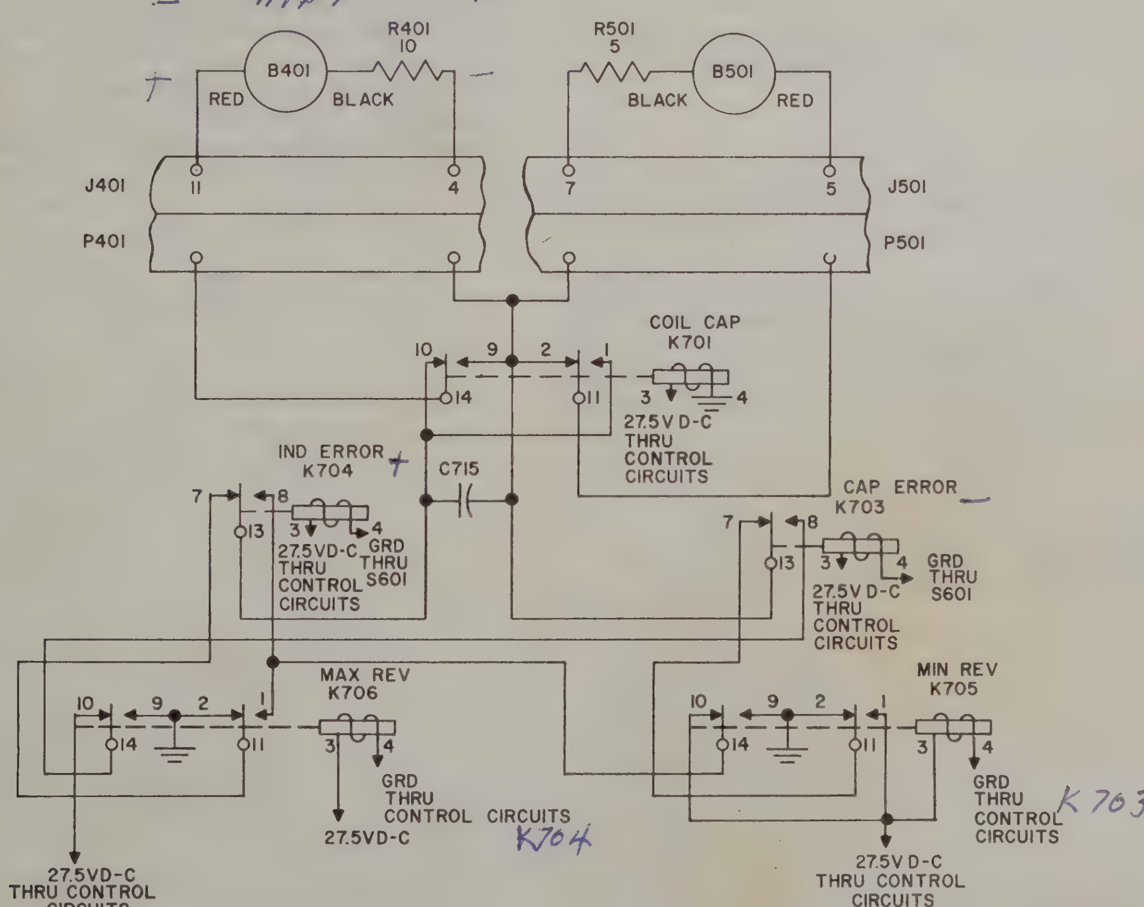


Figure 4-16. Motor Control Circuits, Simplified Schematic Diagram

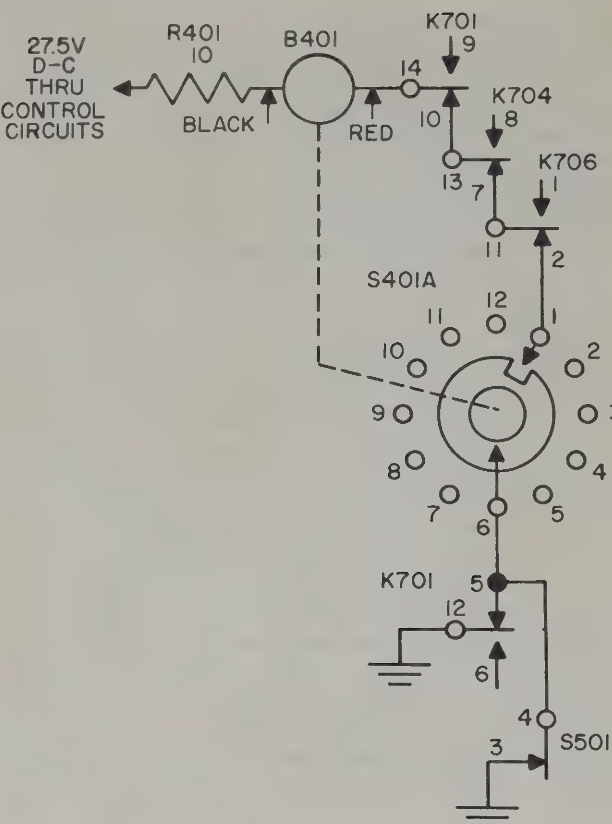


Figure 4-17. Motor B401, Maximum Limit Protection Circuit, Simplified Schematic Diagram

K704-13, K704-7, K706-11, and K706-2. When connected in this manner, motor B401 starts variable inductor L401 toward maximum under control of relay K705.

d. Assume the series tuning elements reach maximum. Relay K706 is energized, and relays K701, K703, K704, and K705 are de-energized. The red B401 lead is connected to 27.5 volts d-c through J401-11, P401-11, K701-14, K701-10, K704-13, K704-7, K706-11, K706-1, K705-14, and K705-10. The black B401 lead is connected to ground through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-2. When connected in this manner, motor B401 starts variable inductor L401 toward minimum under control of relay K706.

e. Steps a through d describe the operation of motor B401 when running under control K703, K704, K705, or K706. Examination of figure 4-16 will show that whenever relay K701 is energized, motor B401 is shorted, and motor B501 is connected into the circuit through contacts of either K703, K704, K705, or K706 as was described in steps a through d for motor B401. Relay K701 is energized when L401 reaches either minimum (running toward minimum) or six turns from minimum (running toward maximum). When relay K701 is energized, motor B501 runs as described in steps a through d for motor B401, and variable capacitor C501 is driven instead of variable inductor L401.

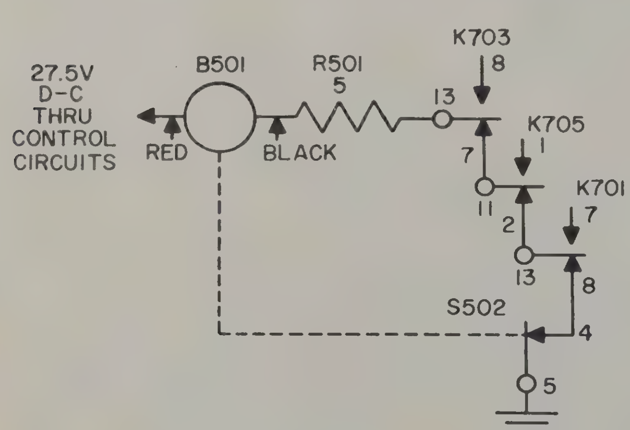


Figure 4-18. Motor B501, Minimum Limit Protection Circuit, Simplified Schematic Diagram

4.4.2 MOTOR PROTECTION CIRCUITS.

Motors B401 and B501 contain protection circuits which assure that either motor will not run past the reversing position. Figure 4-17 illustrates the maximum limit protection circuit for motor B401. Normally, motor B401 is reversed when L401 reaches maximum through contacts of relay K706. Relay K706 is energized when L401 reaches maximum through contacts of S402B, K709, and K708. If for any reason the normal reversing circuits do not function properly and relay K706 is not energized, the ground circuit for motor B401 is removed by switch S401A, thus stopping motor B401. Switch S401A reaches the open position when L401 reaches maximum, but is rotated slightly later than switch S402A, S401B, or S402B. Because

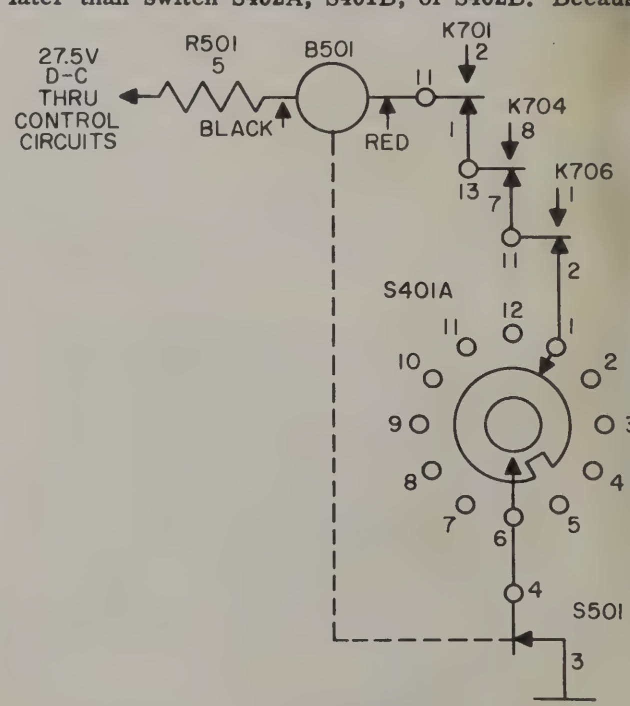


Figure 4-19. Motor B501, Maximum Limit Protection Circuit, Simplified Schematic Diagram

K706 is energized through contacts of S402B when L401 reaches maximum, S401A is not opened unless the normal reversing circuits fail to function properly.

Motor B501 is protected in a similar manner to motor B401 but in both the minimum and maximum positions of C501. Figure 4-18 illustrates the minimum limit protection circuit for motor B501. Normally, motor B501 is removed from the circuit when C501 reaches minimum through contacts of relay K705, and shorted by contacts of relay K701. Relay K705 is energized when C501 reaches minimum through contacts 1 and 3 of switch S502 and contacts 3 and 9 of switch S402A. If, for any reason, the normal switching circuits do not function properly and relay K705 is not energized, the ground circuit for motor B501 is removed by contacts 4 and 5 of switch S502. Contacts 4 and 5 of switch S502 open when C501 reaches minimum but slightly later than contacts 1 and 3 close. Thus, the minimum limit protection circuit does not operate unless the normal switching circuits fail to function properly.

Figure 4-19 illustrates the maximum limit protection circuit for motor B501. Normally, motor B501 is removed from the circuit when C501 reaches maximum through contacts of relay K701. Relay K701 is de-energized when C501 reaches maximum through contacts 1 and 2 of switch S501. If, for any reason, the normal switching circuits do not function properly and relay K701 is not de-energized, the ground circuit for motor B501 is removed by contacts 3 and 4 of switch S501. Contacts 3 and 4 of switch S501 open when C501 reaches maximum but slightly later than contacts 1 and 2 open. Thus, the maximum limit protection circuit does not operate unless the normal switching circuits fail to function properly.

Motors B401 and B501 also are protected from overload and from excess starting and stopping torque by series resistors. (Refer to figure 4-16.) Resistor R401 protects motor B401, and resistor R501 protects motor B501.

4.4.3 AUTOMATIC KEYING CIRCUITS.

The following discussion reviews the operation of the automatic keying circuits and provides detailed circuit tracing. Refer to figures 4-11 and 4-20 throughout steps a through h.

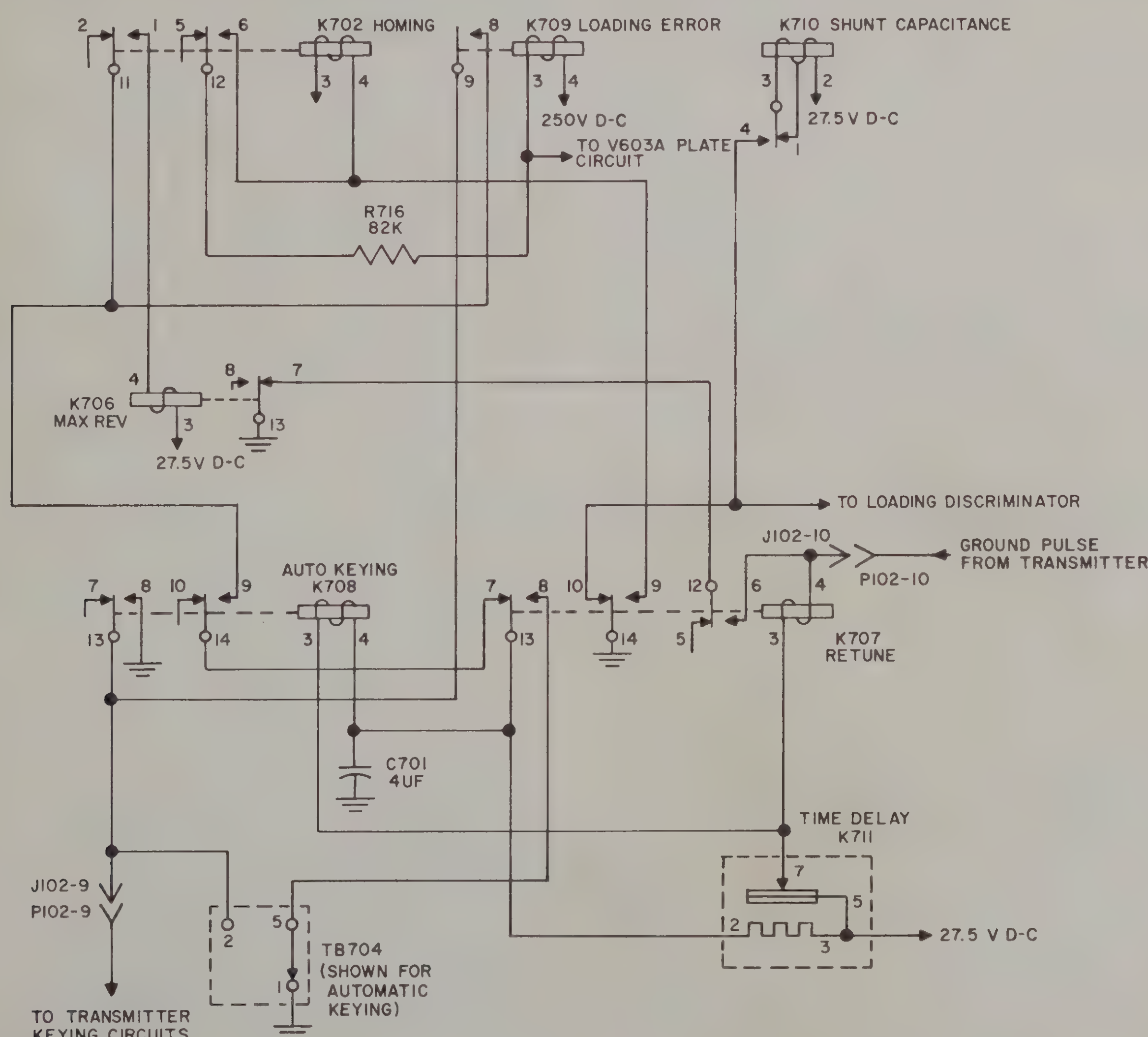


Figure 4-20. Automatic Keying Circuit, Simplified Schematic Diagram

a. When the transmitter is channeled, a ground pulse is provided for relay K707 through P102-10, J102-10, to K707-4. Relay K707 is energized, and a holding ground is provided through K707-6, K707-12, K706-7, and K706-13. Relay K710 is de-energized by contacts 10 and 14 of K707, and the shunt capacitance is removed from the circuit.

b. A ground circuit for relay K702 is provided through K707-9 and K707-14. A ground circuit for relays K708 and K711 is provided through K707-13, K707-8, TB704-5, and TB704-1. If connected for radio silence, terminals 5 and 2 of TB704 are connected, and relays K708 and K711 are energized through the transmitter keying circuits following manual keying. A ground for the transmitter keying circuits is provided by K708-13 and K708-8.

c. An r-f signal from the transmitter appears at the 180L-2 input, and the phasing and loading discriminators are put into operation.

d. The loading discriminator is unbalanced by K707-10 and K707-14. (Refer to figure 4-6.)

e. Relay K709 is energized through action of the loading servo amplifier. The plate current of V703A is applied to terminal 3 of K709 and out terminal 4 to the B-plus supply. Also, a small bleeder current is applied through K707-14, K707-9, K702-6, K702-12, and R716 to terminal 3 of K709 to assure a positive action.

f. A ground circuit is provided for relay K706 through K702-1, K702-11, K709-8, K709-9, K708-13, and K708-8; and relay K706 is energized. When K706 is energized, K706-13 and K706-7 remove the holding ground from relay K707. The automatic homing function is started. Until relay K707 is de-energized and the automatic homing function is started, motor B301 is held by capacitor C711 in a circuit similar to that described in step i of paragraph 4.4.4. Until K707 is de-energized, C711 is connected between the loading servo-amplifier output and the 27.5-volt d-c power source through R718, K707-1, K707-11, K711-7, and K707-5. The low-impedance 27.5-volt d-c power source is comparable to the ground circuit described in step i of paragraph 4.4.4.

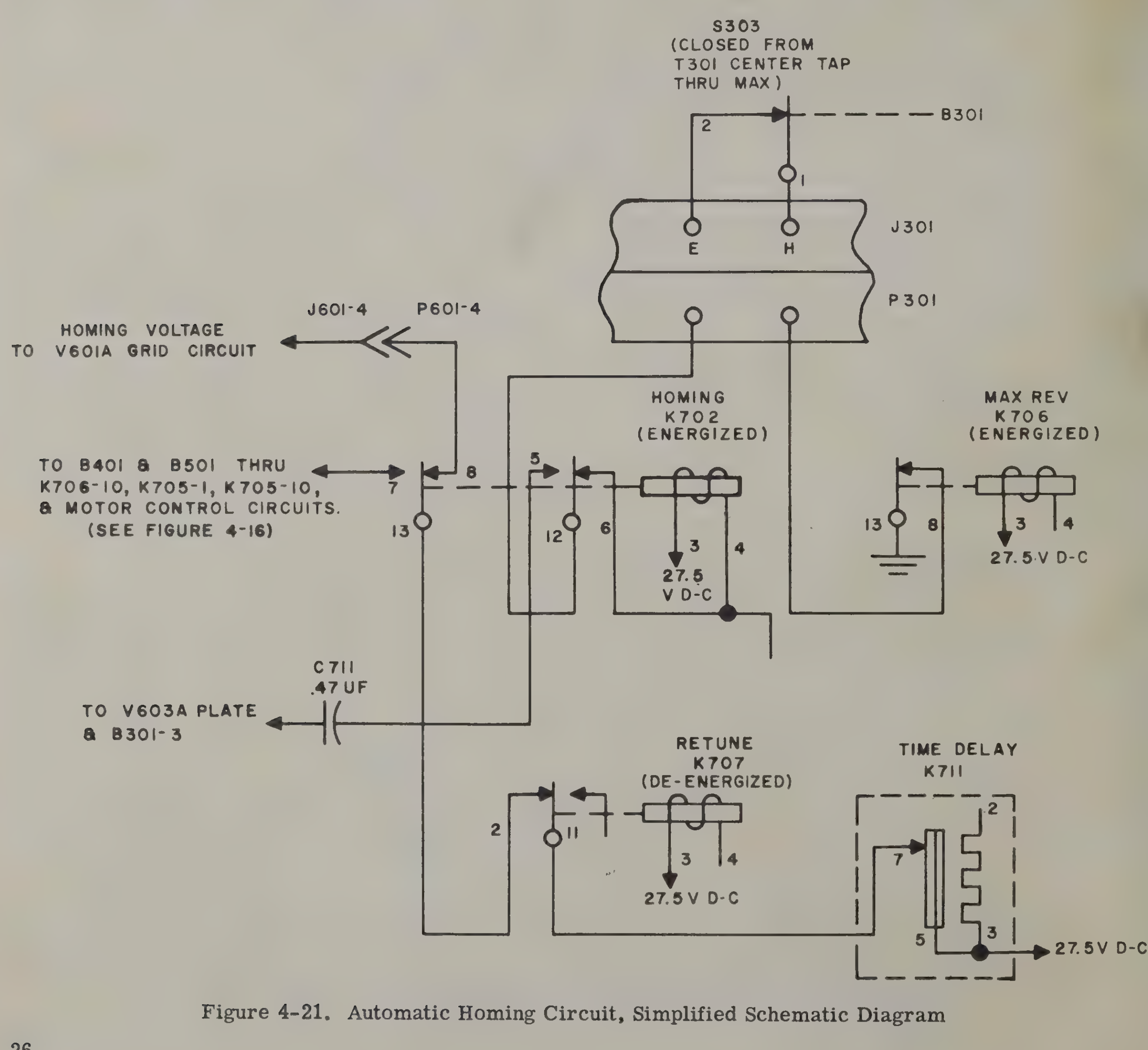


Figure 4-21. Automatic Homing Circuit, Simplified Schematic Diagram

g. A holding ground for relay K708 is provided through K707-13, K707-7, K708-14, K708-9, K709-8, K709-9, K708-13, and K708-8. Capacitor C710 holds relay K708 in the energized position until this ground is established.

h. Terminals 13 and 8 of relay K708 maintain the transmitter keying circuit ground until completion of the tuning cycle.

4.4.4 AUTOMATIC HOMING CIRCUITS.

The following discussion reviews the operation of the automatic homing circuits and provides detailed circuit tracing. Refer to figures 4-9, 4-12, 4-16, 4-21, 7-6, and 7-7 throughout steps a through i.

a. Assume relays K702 and K706 are energized and relay K707 is de-energized. These conditions are met at completion of step f of paragraph 4.4.3.

b. If r-f autotransformer T301 is at or above the center tap position, switch S303 is closed. A holding ground for K702 exists through K702-6, K702-12, P301-E, J301-E, S303-2, S303-1, J301-H, P301-H, K706-8, and K706-13. If T301 is below the center tap position, relay K702 is de-energized, and the automatic homing circuits function as outlined in steps f through j.

c. A positive voltage (27.5 volts d-c) is applied to the input circuit of the loading servo amplifier through K711-5, K711-7, K707-11, K707-2, K702-13, K702-8, P601-4, and J601-4.

d. Because the loading servo-amplifier input is a positive d-c voltage, r-f autotransformer T301 is driven toward minimum and toward the center tap by motor B301.

e. The r-f autotransformer, T301, is driven past the center tap, which opens the ground circuit and de-energizes relay K702. Contacts 8 and 13 of K702 remove the 27.5-volt d-c input to the loading servo amplifier.

f. (Refer to figures 7-6 and 7-7.) A holding ground for K706 is supplied through K706-6, K706-12, K704-5, K704-12, K705-7, K705-13, K709-8, K709-9, K708-13, and K708-8. Resistor R717 replaces resistor R716 to supply K709 bleeder current. (Refer to step e, paragraph 4.4.3.) Resistor R717 is grounded through K702-10, K702-14, K706-8, and 706-13.

g. The loading servo-amplifier input becomes a negative d-c voltage when relay K702 is de-energized, and T301 is driven toward maximum.

h. One of the phasing motors (B401 or B501) is energized through K711-5, K711-7, K707-11, K707-2, K702-13, K702-7 and through the motor control circuits. (Refer to figure 4-16 and paragraph 4.4.1.)

i. When T301 reaches center tap (in the maximum direction), switch S303 closes, and capacitor C711 is grounded through K702-5, K702-12, P301-E, J301-E, S303-2, S303-1, J301-H, P301-H, K706-8, and K706-13. This grounding action shunts capacitor C711 across the loading servo-amplifier output and thereby stops motor B301 at the T301 center tap position.

j. Motor B401 or B501 starts the series tuning elements in the minimum direction. The particular motor and series tuning element in use depends upon the newly selected frequency and also upon the position within the mechanical cycle. (Refer to paragraph 4.3.4.)

4.4.5 MECHANICAL CYCLE CIRCUITS.

The following discussion reviews the mechanical cycle and provides detailed circuit tracing. In the time sequence, steps a through j follow step j of paragraph 4.4.4. It is assumed, for purposes of explanation, that the 180L-2 cannot tune, and the mechanical cycle will therefore continue until K711 opens. Refer to figures 4-13 and 4-22 for steps a through c and step j, and figures 4-13 and 4-23 for steps d through i.

a. Beginning at point a of the mechanical cycle (figure 4-13), relay K706 is energized as described in step f of the preceding paragraph. The red B401 lead is connected to 27.5 volts d-c through J401-11, P401-11, K701-14, K701-10, K704-13, K704-7, K706-11, K706-1, K705-14, and K705-10. The black B401 lead is connected to ground through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-2. When connected in this manner, motor B401 drives variable inductor L401 toward minimum indicated by operation 1 of figure 4-13.

b. When L401 reaches minimum (position B of figure 4-13), relay K701 is energized through P401-9, J401-9, S401B-12, S401B-8, J401-2, P401-2, K704-13, K704-7, K706-11, K706-1, K705-14, and K705-10. Motor B401 is shorted out through terminals 14 and 9 of K701, and L401 stops at the minimum position.

c. Beginning at point b of the mechanical cycle (figure 4-13), the red B501 lead is connected to 27.5 volts d-c through J501-5, P501-5, K701-11, K701-1, K704-13, K704-7, K706-11, K706-1, K705-14, and K705-10. The black B501 lead is connected to ground through J501-7, P501-7, K703-13, K703-7, K705-11, and K705-2. When connected in this manner, motor B501 drives series variable capacitor C501 toward minimum indicated by operation 2 of figure 4-13.

d. When C501 reaches minimum (position C of figure 4-13), relay K705 is energized through P501-3, J501-3, S502-1, S502-3, J501-13, P501-13, P401-14, J401-14, S402A-3, and S402A-9 and held through K705-6, K705-12, K703-5, K703-12, P401-13, J401-13, S402B-4, S402B-10 and 12, J401-8, P401-8, K709-8, K709-9, K708-13, and K708-8. Terminals 7 and 13 of K705 remove the holding ground from relay K706, and relay K706 is de-energized. Terminals 11 and 2 of K701 short out motor B501, stopping C501 at the minimum position.

e. Beginning at point c of the mechanical cycle (figure 4-13), the black B401 lead is connected to 27.5 volts d-c through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-1. The red B401 lead is connected to ground through J401-11, P401-11, K701-14, K701-10, K704-13, K704-7, K706-11, and K706-2. When connected in this manner, motor B401 drives variable inductor L401 toward maximum indicated by operation 3 of figure 4-13.

f. When L401 reaches six turns from minimum (position D of figure 4-13), relay K701 is energized through P401-9, J401-9, S401B-12, S401B-11,

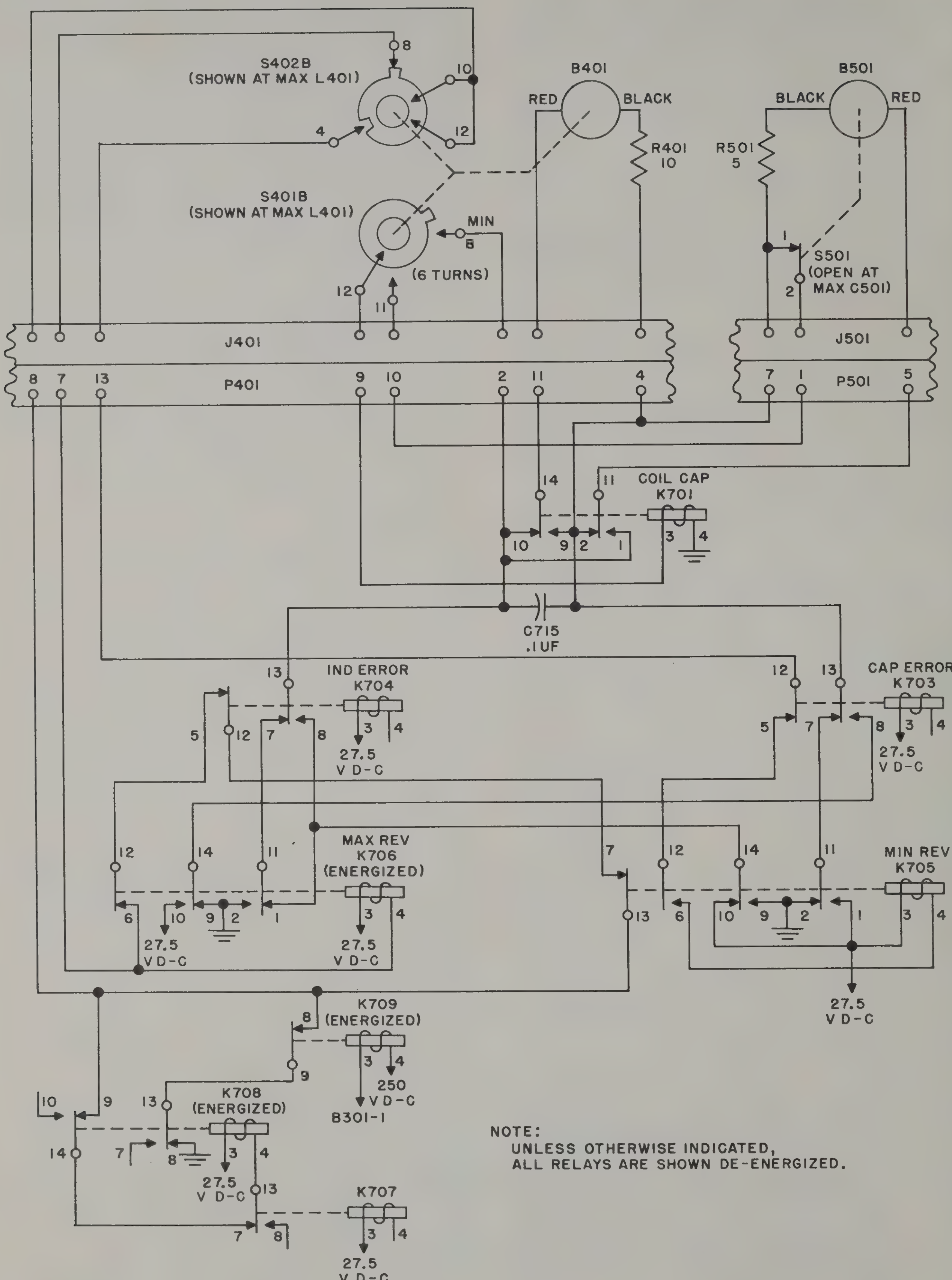


Figure 4-22. Mechanical Cycle Circuit (Toward Minimum), Simplified Schematic Diagram

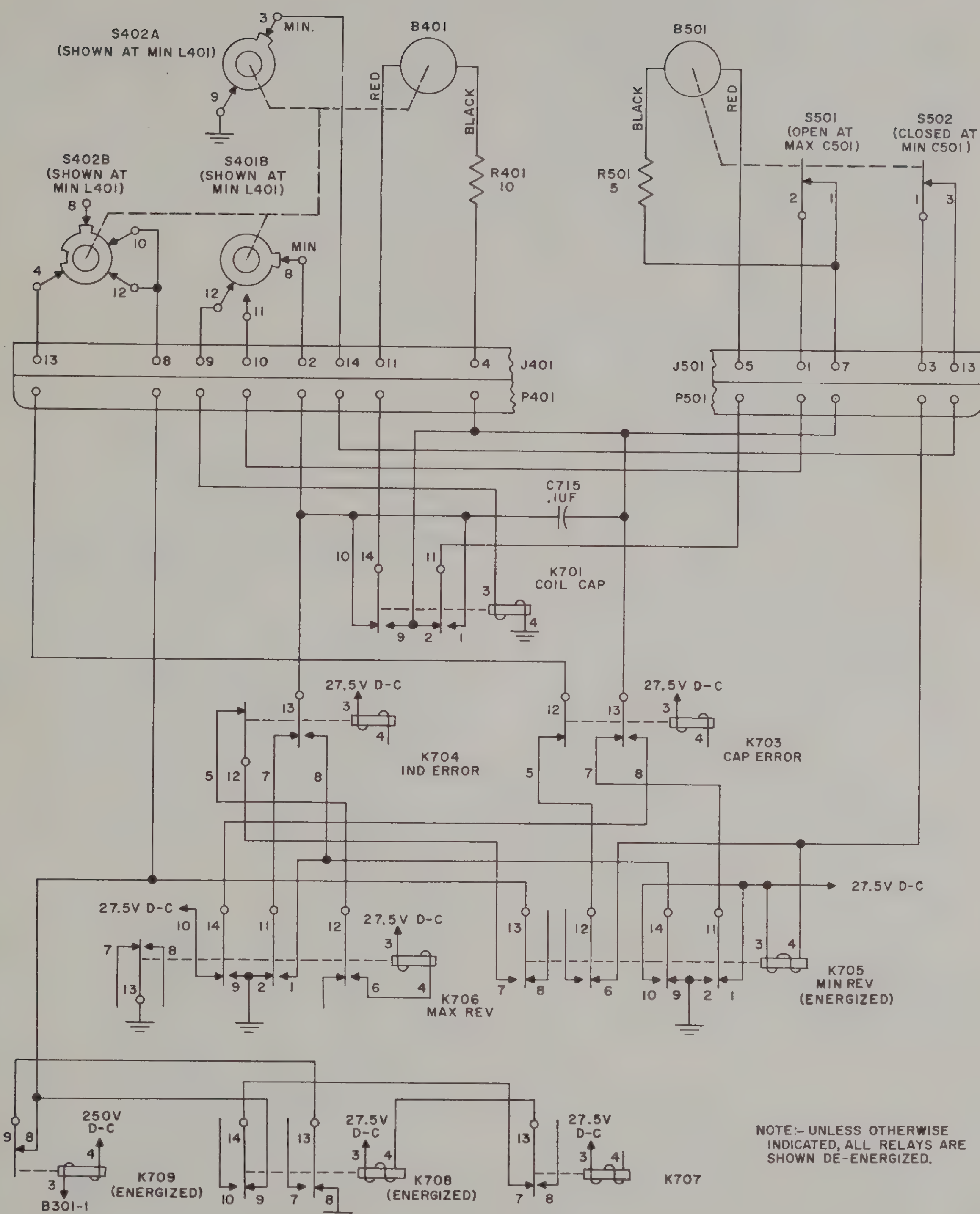


Figure 4-23. Mechanical Cycle Circuit (Toward Maximum), Simplified Schematic Diagram

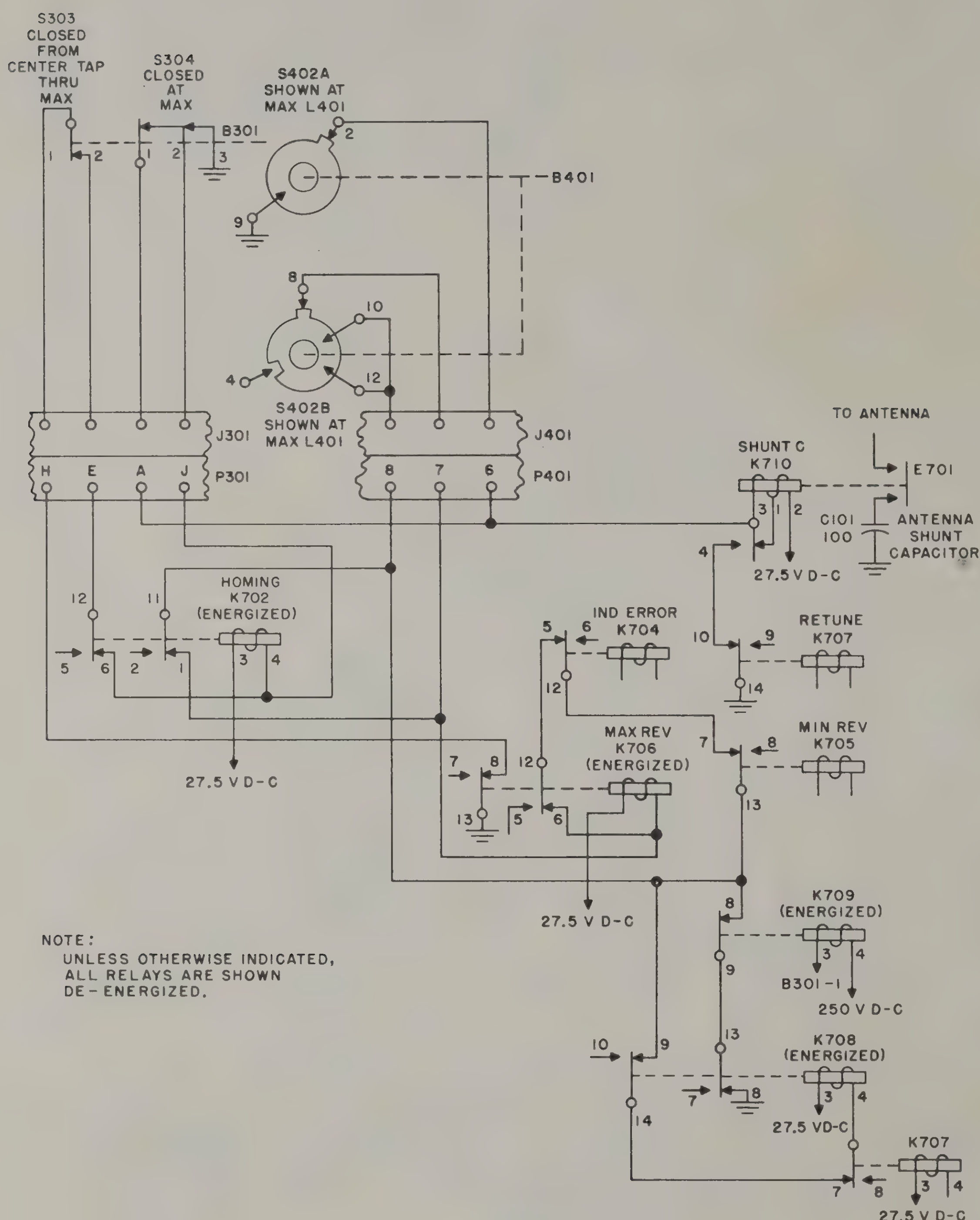


Figure 4-24. Shunt Capacitor Circuit, Simplified Schematic Diagram

J401-10, P401-10, P501-1, J501-1, S501-2, S501-1, J501-7, P501-7, K703-13, K703-7, K705-11, and K705-1. Motor B401 is shorted out through terminals 14 and 9 of K701, and L401 stops at the six turns from minimum position.

g. Beginning at point d of the mechanical cycle (figure 4-13), the black B501 lead is connected to 27.5 volts d-c through J501-7, P501-7, K703-13, K703-7, K705-11, and K705-1. The red B501 lead is connected to ground through J501-5, P501-5, K701-11, K701-1, K704-13, K704-7, K706-11, and K706-2. When connected in this manner, motor B501 drives variable capacitor C501 toward maximum indicated by operation 4 of figure 4-13.

h. When C501 reaches maximum (position E of figure 4-13), S501-1 and S501-2 open, and relay K701 is de-energized. Motor B501 is shorted out through terminals 11 and 2 of relay K701, and C501 stops at the maximum position.

i. Beginning at point e of the mechanical cycle (figure 4-13), the black B401 lead is connected to 27.5 volts d-c through J401-4, P401-4, K703-13, K703-7, K705-11, and K705-1. The red B401 lead is connected to ground through J401-11, P401-11, K701-14, K701-10, K704-13, K704-7, K706-11, and K606-2. When connected in this manner, motor B401 drives variable inductor L401 toward maximum indicated by operation 5 of figure 4-13.

j. When L401 reaches maximum (position A of figure 4-13), shunt capacitor C101 is switched into the circuit as explained in the following paragraph. Relay K706 is energized through P401-7, J401-7, S402B-8, S402B-10 and 12, J401-8, P401-8, K709-8, K709-9, K708-13, and K708-8 and held as described in step f of the preceding paragraph. The K705 ground circuit is removed by S402B-4 and S402B-10 and 12. The mechanical cycle repeats as outlined in steps a through i except that K710 is energized and shunt capacitor C101 is shunted from the antenna to ground.

4.4.5.1 ANTENNA SHUNT CAPACITANCE CIRCUITS. Refer to figure 4-24. Antenna shunt capacitor C101 is shunted from the antenna to ground through contacts of relay K710 whenever T301 or both L401 and C501 reach maximum. Because the series tuning elements are always started toward minimum and r-f autotransformer T301 is always started toward the center tap position, relay K710 is not energized until the need for shunt capacitance has been determined. Two possible methods exist through which shunt capacitor C101 may be switched into the circuit. These methods are described in detail as follows.

After the entire mechanical cycle has been completed, and the phasing discriminator fails to find a correct tuning point, the series tuning elements are at the maximum position. At the maximum position of the series tuning elements, switches S402A and S402B are at the positions shown in figure 4-24. The following steps a through f describe the resultant control circuit operation:

a. A ground path for relay K710 exists through P401-6, J401-6, S402A-2, and S402A-9.

b. Relay K710 is energized, and shunt capacitor C101 is shunted from the antenna to ground.

c. A holding ground for K710 is supplied through K710-3, K710-4, K707-10, and K707-14.

d. Relay K706 is energized through P401-7, J401-7, S402B-8, S402B-10 and 12, J401-8, P401-8, K709-8, K709-9, K708-13, and K708-8.

e. A holding ground for K706 is supplied through K706-6, K706-12, K704-5, K704-12, K705-7, K705-13, K709-8, K709-9, K708-13, and K708-8.

f. The mechanical cycle is started, and L401 is driven toward minimum. (Refer to paragraph 4.4.5) Shunt capacitor C101 remains across the antenna until relay K707 is energized through channel selection.

After the series tuning elements reach a tuning point and the phasing discriminator is satisfied, relays K703, K704, K705, and K706 are de-energized, and r-f autotransformer T301 is allowed to seek a resonant point. If T301 cannot find a tuning point and runs to maximum, shunt capacitor C101 is switched into the circuit. When T301 reaches maximum, switch S304 is at the position shown in figure 4-24. The following steps a through h describe the resultant control circuit operation:

a. A ground path for relay K710 exists through P301-A, J301-A, S304-1, S304-2, and S304-3.

b. Relay K710 is energized, and shunt capacitor C101 is shunted from the antenna to ground.

c. A holding ground for K710 is established through K710-3, K710-4, K707-10, and K707-14.

d. Relay K702 is energized through P301-J, J301-J, S304-2, and S304-3.

e. Relay K706 is energized through K702-1, K702-11, K709-8, K709-9, K708-13, and K708-8.

f. A holding ground for K706 is supplied through K706-6, K706-12, K704-5, K704-12, K705-7, K705-13, K709-8, K709-9, K708-13, and K708-8.

g. A holding ground for K702 is supplied through K702-6, K702-12, P301-E, J301-E, S303-2, S303-1, J301-H, P301-H, K706-8, and K706-13.

h. The automatic homing circuits are started, and T301 is driven to center tap. (Refer to paragraph 4.4.4.) Shunt capacitor C101 remains across the antenna until relay K707 is energized through channel selection.

4.4.6 TIME-DELAY CIRCUIT. Refer to figure 4-25. Relay K711 is included with the 180L-2 control circuits as a time-delay safety measure. If the loading or phasing discriminators are not satisfied within 45 seconds after channel selection, contacts of K711 remove 27.5 volts d-c from relays K701, K703, K704, K705, K706, K707, K708, and from the transmitter keying circuits. The thermal elements of K711 will again close within a period of 60 seconds or less, allowing for rechanneling. The following steps a through h describe the operation of the time-delay circuit following channel selection:

a. A ground circuit is provided from the transmitter channeling circuits through P102-10, J102-10, energizing relay K707.

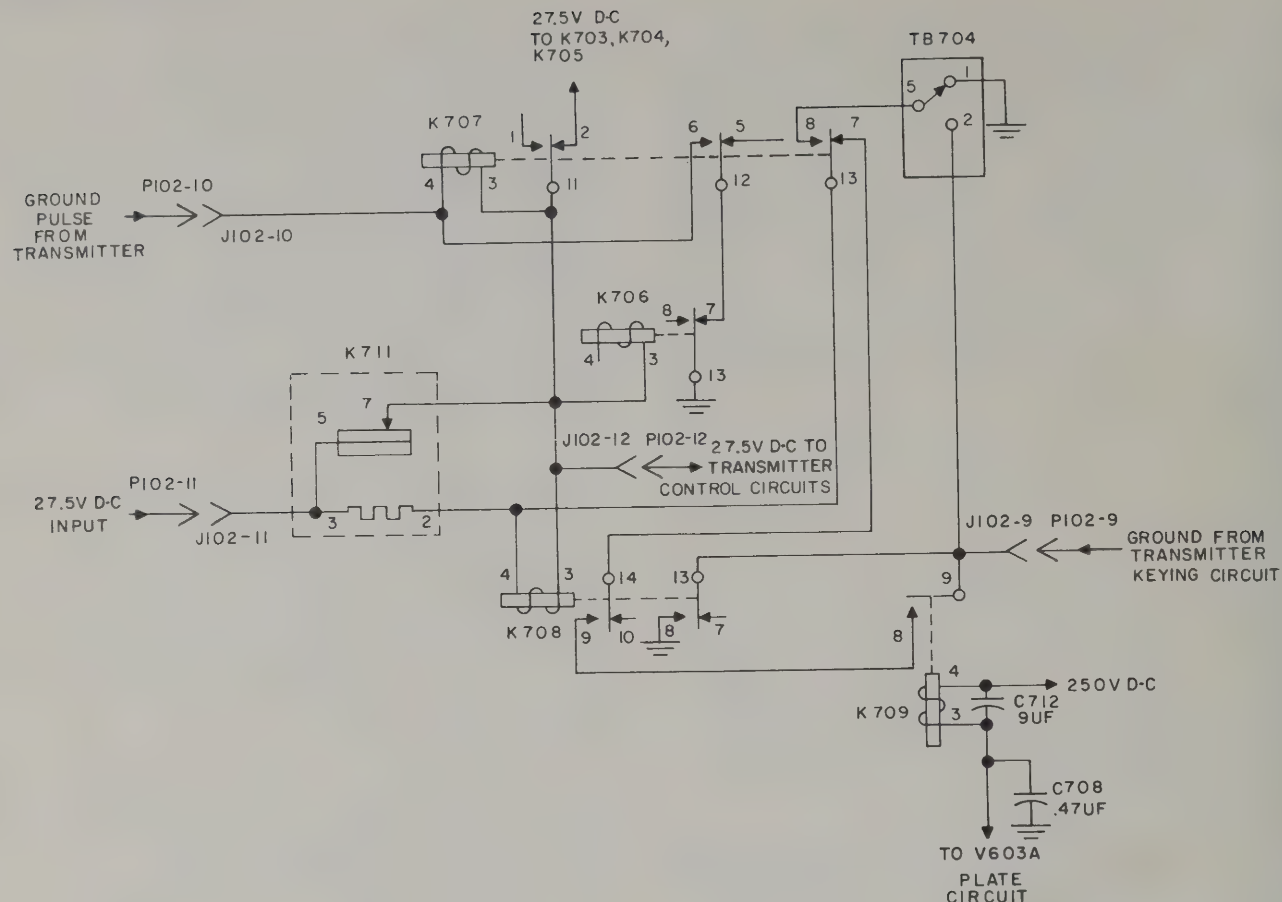


Figure 4-25. Time-Delay Circuit, Simplified Schematic Diagram

b. A path is established for the 27.5-volt d-c circuit through P102-11, J102-11, K711-3, K711-2, K707-13, K707-8, TB704-5, and TB704-1.

c. If connected for radio silence, TB704-5 connects to TB704-2, and the 27.5-volt d-c ground path is not established until the transmitter is keyed manually.

d. The operation continues as outlined in steps b through f of paragraph 4.4.3 until relay K706 is energized.

e. The K707 holding ground, through K706-13, K706-7, K707-12, and K707-6, is removed when relay K706 is energized.

f. Contact 13 of K707 removes the previous 27.5-volt d-c path (step b), and a new path is selected through P102-11, J102-11, K711-3, K711-2, K708-13, K708-7, K708-14, K708-9, K709-8, K709-9, K708-13, and K708-8. (Relays K708 and K709 are energized during the automatic keying function. Refer to steps b, e, and g, paragraph 4.4.3.)

g. The 27.5-volt d-c path described in step f remains until relay K708 or K709 is de-energized. After the tuning cycle is complete, relays K708 and K709 are de-energized, and the energizing voltage is removed from relay K711.

h. If the entire tuning cycle following keying continues for a period in excess of 30 to 55 seconds, the bimetal contact of K711 (terminal 5) opens the 27.5-volt d-c supply, and the tuning operations cease.

4.5 OUTPUT CIRCUITS.

Automatic Antenna Tuners 180L-3 and 180L-3A include antenna transfer relay K712 which is discussed in paragraph 4.5.1. Automatic Antenna Tuner 180L-3A includes antennna grounding relay K713 which affords protection to the receivers of a dual installation and is discussed in paragraph 4.5.2.

4.5.1 ANTENNA TRANSFER CIRCUIT.

Refer to figure 4-26. The r-f output signal from the transmitter, after passing through Automatic Antenna Tuner 180L-3 or 180L-3A, is applied through contacts of antenna transfer relay K712 to the antenna. Relay K712, which includes vacuum switch S701 and solenoid L703, is energized through the transmitter keying circuit during manual keying or through K708 contacts during tuning. Therefore, the transmitter to antenna path is open except when transmission is in progress. In the key-up position, the received r-f signal from the antenna is passed through switch S701, J103, and P103 to the receiver input connector thus bypassing the 180L-3 or 180L-3A tuning circuits. Relay K712 is not included with Automatic Antenna Tuner 180L-2, and the r-f signal during both transmission and reception is passed through the tuning circuits.

4.5.2 ANTENNA GROUNDING CIRCUIT.

When two transmitters and two receivers or two transceivers are employed in one aircraft, the r-f power output from one transmitter may damage the alternate receiver if proper protection is not provided. Also, the proximity of the aircraft antennas may cause interaction which will change the electrical characteristics of each antenna. With Automatic Antenna Tuner 180L-3A, both the overload and the antenna interaction dangers are removed. Figure 4-27 illustrates a dual-installation system employing two transceivers and two 180L-3A Automatic Antenna Tuners. The following paragraphs describe the operation of such a system.

Steps a through e describe the operation when transmitter number 1 is keyed and transmitter number 2 is not keyed:

a. Relay K712 of 180L-3A number 1 is grounded through J102-9, P102-9, and the key of transmitter number 1, energizing relay K712.

b. Relay K713 of 180L-3A number 2 is grounded through TB704-2, J102-16, and the key of transmitter number 1, energizing relay K713.

c. The r-f output signal of transmitter number 1 is applied through P101-1, J101-1, the tuning circuits of 180L-3A number 1, switch S701 or K712, and E102 to antenna number 1, thus radiating the output signal of transmitter number 1.

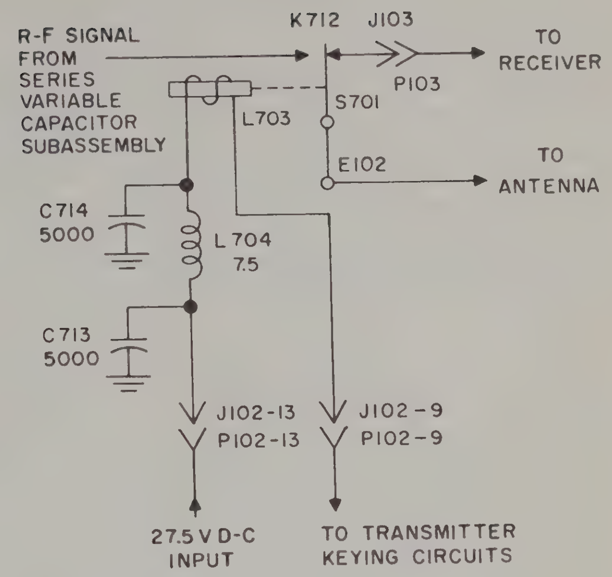


Figure 4-26. Output Circuit, Simplified Schematic Diagram

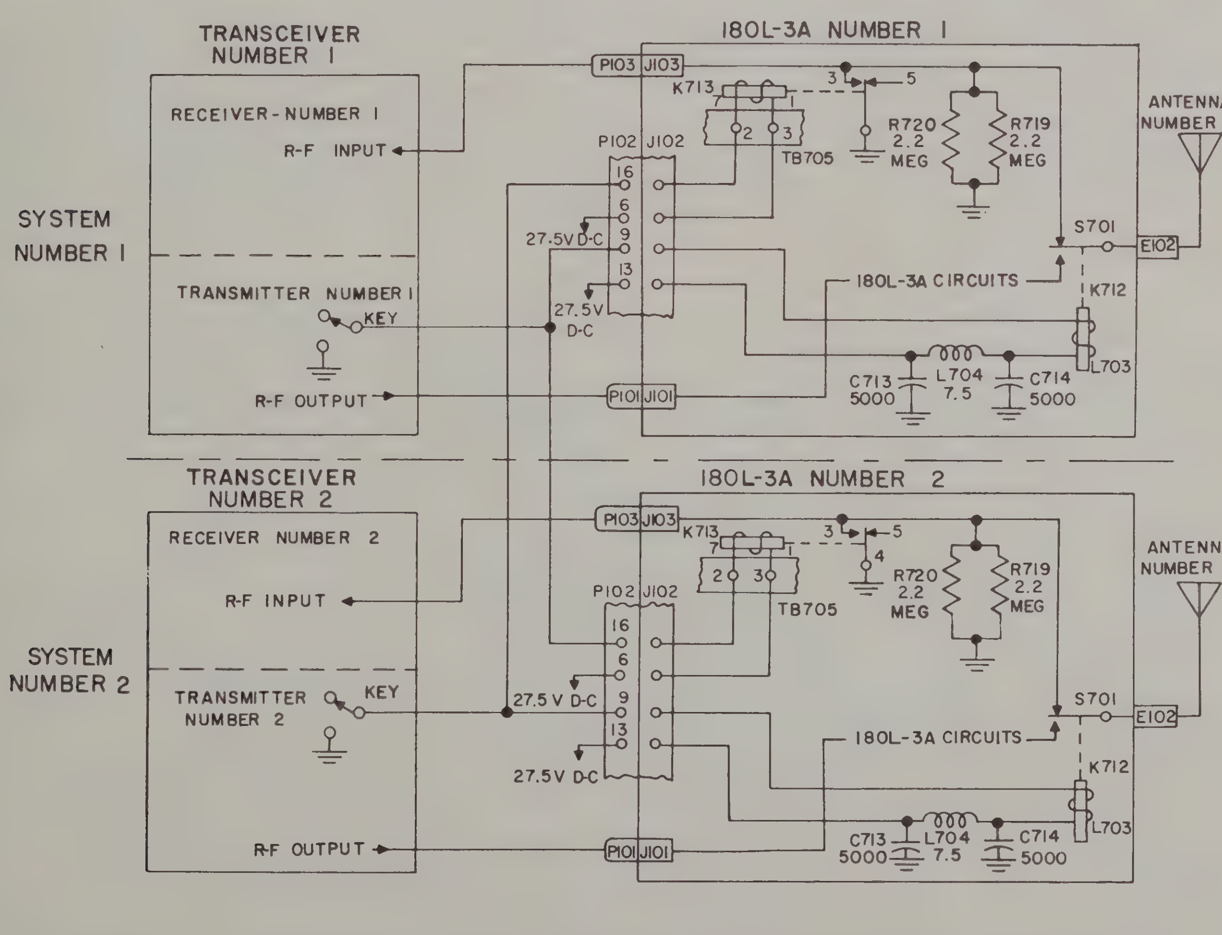


Figure 4-27. Dual-Installation, Antenna Grounding Circuits, Simplified Schematic Diagram

d. Because relay K712 of 180L-3A number 1 is energized, the r-f input circuit of receiver number 1 is open.

e. Antenna number 2 is grounded through E102, switch S701 of K712, K713-3, and K713-4. Therefore, the r-f input circuit of receiver number 2 is protected and interaction between antennas number 1 and 2 is prevented.

Steps a through e describe the operation when transmitter number 2 is keyed and transmitter number 1 is not keyed:

a. Relay K712 of 180L-3A number 2 is grounded through J102-9, P102-9, and the key of transmitter number 2, energizing relay K712.

b. Relay K713 of 180L-3A number 1 is grounded through TB704-2, J102-16, P102-16, and the key of transmitter number 2, energizing relay K713.

c. The r-f output signal of transmitter number 2 is applied through P101-1, J101-1, the tuning circuits of 180L-3A number 2, switch S701 of K712 and E102 to antenna number 2, thus radiating the output signal of transmitter number 2.

d. Because relay K712 of 180L-3A number 2 is energized, the r-f input circuit of receiver number 2 is open.

e. Antenna number 1 is grounded through E102, switch S701 of K712, K713-3, and K713-4. Therefore, the r-f input circuit of receiver number 1 is protected, and interaction between antennas number 1 and 2 is prevented.

Steps a and b describe the operation when neither transmitter is keyed:

a. The r-f signal received by antenna number 1 is applied through E102, S701 of K712, J103, and P103 to the input circuit of receiver number 1. Resistors R719 and R720 of 180L-3A number 1 provide a static drain for precipitation charges developed across antenna number 1 during reception.

b. The r-f signal received by antenna number 2 is applied through E102, S701 of K712, J103, and P103 to the input circuit of receiver number 2. Resistors R719 and R721 of 180L-3A number 2 provide a static drain for precipitation charges developed across antenna number 2 during reception.

SECTION V
MAINTENANCE

5.1 GENERAL.

NOTE

The following maintenance procedures referencing only the 180L-2 also apply to Automatic Antenna Tuners 180L-3 and 180L-3A.

This section provides instructions essential for both preventive and corrective maintenance of Automatic Antenna Tuner 180L-2. Before attempting to perform maintenance on this equipment, maintenance personnel should be thoroughly familiar with the physical make-up of the equipment and reasonably familiar with the theory of operation.

Preventive maintenance includes necessary procedures to be performed during the regularly scheduled maintenance period. These include inspection, lubrication, and a complete operational check.

When it has been determined that Automatic Antenna Tuner 180L-2 is not operating correctly, it is necessary to perform the systematic procedures under corrective maintenance. These procedures include a system trouble analysis for locating the trouble to a faulty subassembly, trouble-isolation procedures for locating the faulty component within a subassembly, overhaul and repair procedures, and alignment procedures.

Throughout this section, references are made to meter indications and attenuator settings of various pieces of test equipment. These indications are not necessarily equipment specifications but are approximate values encountered on a large number of properly operating units. It is possible that the equipment will operate properly with different indications from those stated, because many variable factors are involved. It is absolutely essential, however, that the test equipment in use be calibrated properly, terminated properly, and otherwise in excellent condition.

5.2 PREVENTIVE MAINTENANCE.

Preventive maintenance is performed by maintenance personnel during a regularly scheduled maintenance period. This includes a thorough visual inspection of detailed parts and a complete operational check. In addition, lubrication should be performed where needed during these maintenance periods. If subassembly removal is necessary for inspection or lubrication, refer to paragraph 5.3.2.

5.2.1 LUBRICATION.

Inspect components requiring lubrication at every regular maintenance period. If parts appear to be clean, sufficiently lubricated, and free running, lubrication may be omitted until the following period. If the old lubricant has become hard or dirty, clean the parts to be lubricated with materials listed in table 5-10. All motor bearings are factory lubricated for the life of the motor, and no further lubrication is necessary. Refer to table 5-1 and figures 5-1 through 5-5 for the necessary lubrication data.

CAUTION

Do not operate the 180L-2 equipment following cleaning until the relubrication procedures have been performed.

TABLE 5-1. LUBRICATION OF EQUIPMENT

SUBASSEMBLY	PART	REFERENCE NUMBER	FIGURE NUMBER	LUBRICANT	METHOD OF APPLICATION
Variable Inductor	Gear posts	1	5-1	MIL-L-7870	Dropper
	Oil wicks	2	5-1, 5-2	MIL-L-7870	Dropper
	Bearings	3	5-1, 5-2	MIL-L-7870	Dropper
	Lower ceramic coil bearings	4	5-1	Molykote-Z	Brush or suitable volatile liquid vehicle

TABLE 5-1. LUBRICATION OF EQUIPMENT (Cont)

SUBASSEMBLY	PART	REFERENCE NUMBER	FIGURE NUMBER	LUBRICANT	METHOD OF APPLICATION
Variable Inductor (Cont)	Teeth of gear O406 (See note.)	5	5-2	MIL-G-7421	Brush
	Special bearing	6	5-2	Dow-Corning No. 200	Dropper
Variable Capacitor	C101 bearing surfaces	7	5-3	MIL-L-6085	Dropper
	Gear posts	8	5-3, 5-4	MIL-L-7870	Dropper
	Bearings	9	5-3, 5-4	MIL-L-7870	Dropper
	Worm gear	10	5-3	MIL-G-7421 (80%); Molykote-Z (20%)	Brush
R-F Autotransformer	Bronze bearings	11	5-5	MIL-L-7870	Dropper
	Gear posts	12	5-5	MIL-L-7870	Dropper
	Shaft O307, O309	13	5-5	MIL-G-7421 (80%); Molykote-Z (20%)	Brush

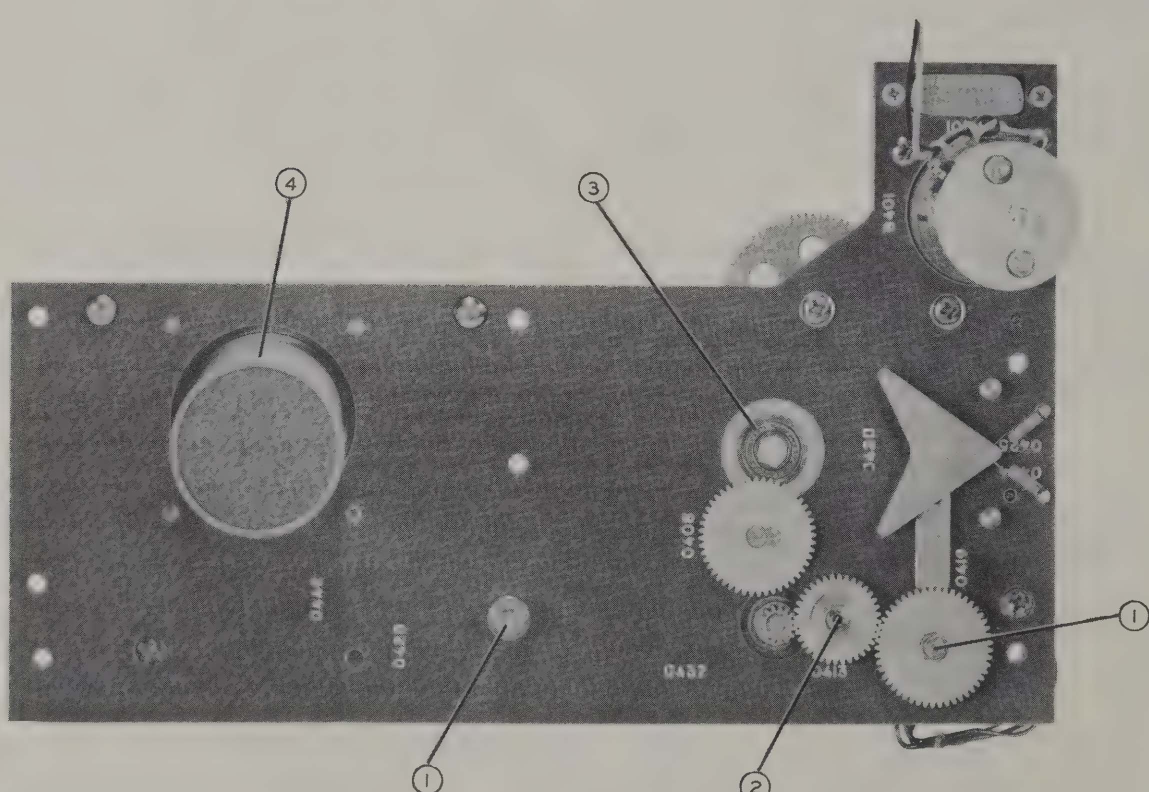


Figure 5-1. Variable Inductor Subassembly, Top View with Drums Removed, Lubrication Points

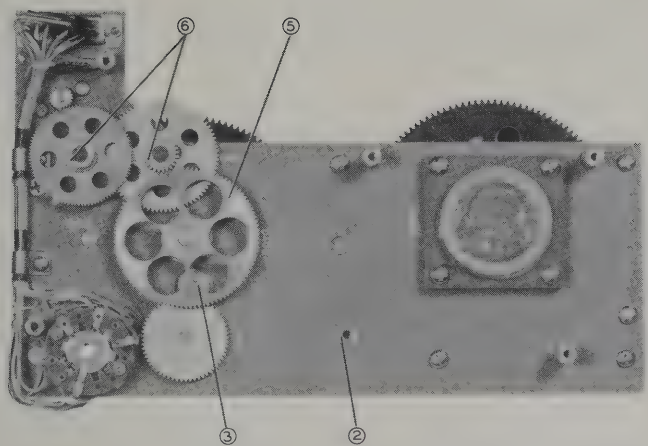


Figure 5-2. Variable Inductor Subassembly, Bottom View, Lubrication Points

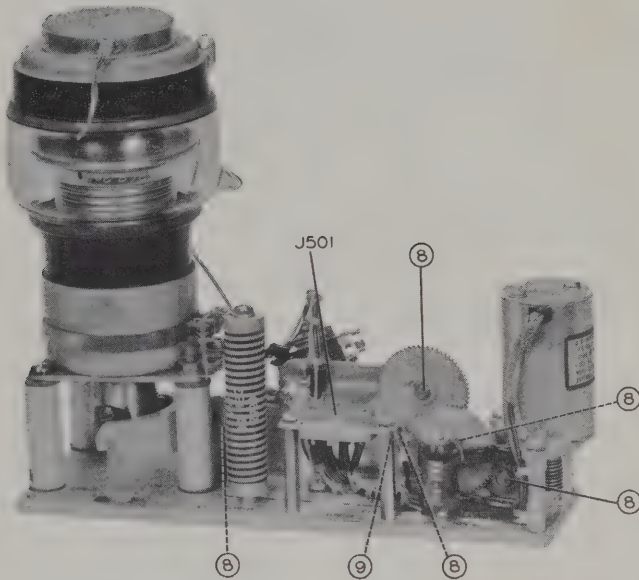


Figure 5-4. Variable Capacitor Subassembly, Rear View, Lubrication Points

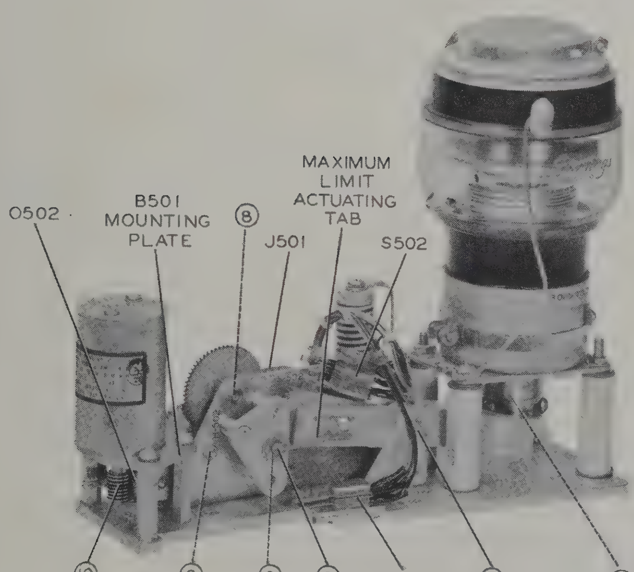


Figure 5-3. Variable Capacitor Subassembly, Front View, Lubrication Points

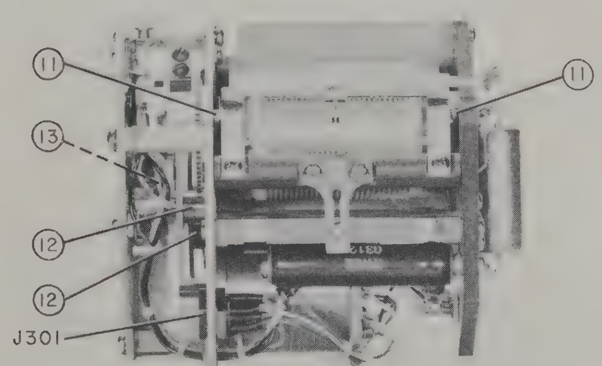


Figure 5-5. R-F Autotransformer Subassembly, Side View, Lubrication Points

5.2.2 OPERATIONAL CHECK.

The operational check is a complete detailed performance test which presents a method of checking each function of Automatic Antenna Tuner 180L-2. The operational check should be performed at every regular maintenance period to make certain that the antenna tuner is in good operating condition. In addition, the operational check may be used to verify defects and as a final test after isolation and correction of trouble. The operational check is designed for use with the test equipment listed in table 2-1 of this handbook.

Before performing the operational checks, perform the preliminary operations described in steps a, b, c, d, e, and h of paragraph 5.3.1.1. (Refer to figures 5-11 and 5-12 throughout these tests.)

5.2.2.1 MECHANICAL CYCLE TEST. Perform the following operations:

a. Perform the preliminary operations outlined above.
b. Jumper terminals 11 and 12 of test point 1 (P102). (Refer to figure 5-10.)
c. Turn the power on and allow sufficient time for warmup.
d. Connect the positive terminal of the 1.5-volt test battery to terminal 1 of test point 5 (P203) and the negative terminal to ground. (Refer to figure 5-6.) Do not remove the test battery until completion of step m.
e. Connect the positive terminal of a second test battery to P203-2, and connect the negative terminal to ground.
f. Manually key the transmitter, and observe for indications as listed in steps g and h.
g. The r-f autotransformer, T301, should run to minimum (roller toward front panel) and remain stalled throughout the remainder of the mechanical cycle test.

NOTE

Do not lift the roller of T301 and move to a different position as misalignment will result.

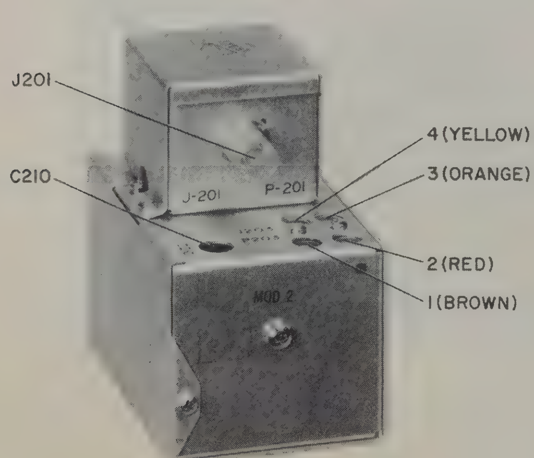


Figure 5-6. Discriminator Subassembly, Test Point Location

h. The series tuning elements should run continuously in the following sequence: L401 runs to minimum (tape onto the metal drum); C501 runs to minimum (bellows move downward); L401 runs six turns toward maximum; C501 runs to maximum; L401 runs to maximum; K710 is energized; the cycle continues with K710 energized.
i. After the series tuning elements have completed at least one cycle as stated in step h, remove the test battery from P203-2 at a time when L401 is running toward maximum (tape onto the ceramic drum). The series tuning elements should continue running as stated in step h with K710 energized.
j. After the series tuning elements have completed at least one cycle with the test battery removed from P203-2, reconnect the test battery with the opposite 1.5 volts (negative 1.5 volts to P203-2 and positive 1.5 volts to ground). The series tuning elements should continue running as stated in step h with K710 energized.
k. After the series tuning elements have completed at least one cycle as stated in step h, remove the test battery from P203-2 at a time when L401 is running toward maximum. All movement should stop.
l. Reconnect the test battery as outlined in step e. The series tuning elements should run as stated in step h with K710 energized.
m. Remove the test battery from P203-2 at a time that L401 is running toward minimum. All movement should stop.
n. Remove both test batteries and unkey the transmitter. Momentarily remove the 27.5-volt d-c input to the 180L-2 to de-energize relay K710.

5.2.2.2 RETUNE CYCLE TEST. Perform the following operations:

a. After completion of step n, paragraph 5.2.2.1, rotate the channel selector to a new channel. The transmitter should be keyed automatically. (The automatic keying function may be checked by rotating the OFF PHONE CW switch to the CW position and monitoring the 400-cps sidetone signal from the 618S-1 or 618S-4 PHONE jack.)
b. Connect the negative terminal of the 1.5-volt test battery to P203-1, and connect the positive terminal to ground. Variable inductor L401 should run toward minimum (tape onto the metal drum), and r-f autotransformer T301 should run toward maximum (roller toward the ungrounded end, away from the front panel).
c. Stop L401 before reaching minimum by momentarily applying plus 1.5 volts between P203-2 and ground (positive 1.5 volts to P203-2 and negative 1.5 volts to ground).
d. After T301 has passed the center tap position (in the maximum direction), again apply 1.5 volts to P203-2 as outlined in step c. The r-f autotransformer, T301, should stop, and variable inductor L401 should run toward minimum.
e. Remove the voltage from P203-2. The r-f autotransformer, T301, should resume running toward maximum, and variable inductor L401 should stop.
f. After T301 reaches maximum, relay K710 should be energized and T301 should reverse and run toward

minimum. When T301 reaches the center tap position (in the minimum direction), T301 should stop and L401 should run toward minimum.

g. Momentarily apply plus 1.5 volts to P203-2 and negative 1.5 volts to ground. Variable inductor L401 should stop, and r-f autotransformer T301 should run toward maximum.

h. Remove the voltage from P203-1. The r-f autotransformer, T301, should stop, and the transmitter should be keyed.

5.2.2.3 AUTOMATIC HOMING TEST. Perform the following operations:

a. Remove both test batteries but maintain the equipment setup established in paragraphs 5.2.2.1 and 5.2.2.2.

b. Connect the positive terminal of the 1.5-volt test battery to terminal 2 of P203, and connect the negative terminal to ground.

c. Manually key the transmitter, and observe the movement of variable inductor L401 and variable capacitor C501. Remove the test battery when C501 reaches maximum (bellows near the top), and L401 reaches a point where half the turns are on each drum.

d. Manually position the roller of T301 to three turns from maximum (three turns from the end of T301 farthest from the front panel).

e. Rotate the channel selector to a different channel. Relay K710 should be de-energized, and the transmitter should be keyed automatically.

f. Momentarily apply negative 1.5 volts to P203-1 (negative 1.5 volts to P203-1 and positive 1.5 volts to ground). The r-f autotransformer, T301, should run toward minimum until the center tap position is reached.

g. When T301 reaches the center tap position, L401 should run toward minimum.

h. Momentarily apply positive 1.5 volts to P203-2 (positive 1.5 volts to P203-2 and negative 1.5 volts to ground). Variable inductor L401 should stop, and the transmitter should be unkeyed.

5.2.2.4 TIME-DELAY RELAY TEST. Perform the following operations:

a. Remove the power from the 180L-2, and wait at least three minutes for relay K711 to cool. Maintain the equipment setup established in paragraphs 5.2.2.1 through 5.2.2.3.

b. Remove the jumper between P102-11 and P102-12.

c. Apply plus 1.5 volts to P203-1 (positive 1.5 volts to P203-1 and negative 1.5 volts to ground).

d. Apply power to the 180L-2 and select a new channel by rotation of the channel selector. The transmitter should be keyed automatically.

e. Allow the 180L-2 tuning circuits to function continuously until relay K711 opens. Relay K711 should open in 50 seconds ±5 seconds, stopping all motion in the 180L-2 and unkeying the transmitter.

5.2.2.5 PHASING SERVO-AMPLIFIER TEST. Perform the following operations:

a. Remove the dust cover and servo-amplifier cover.

b. Perform steps b through e of paragraph 5.3.1.1.

c. Complete the test connections as indicated in figure 5-7.

d. Turn the power on and allow time for warmup.

e. Connect the positive terminal of the 1.5-volt test battery through a 1-megohm potentiometer to terminal 2 of test point 5 (P203), and connect the negative terminal to ground. Set the 1-megohm potentiometer for minimum voltage on the vtvm.

f. Manually key the transmitter, and slowly increase the voltage applied to P203-2 by varying the 1-megohm potentiometer.

g. Observe switch S601. (Refer to figure 5-9.) At the point where S601 operates, the indication on the vtvm should be between 0.1 and 0.15 volt d-c. (If the indication is not between these limits, refer to paragraph 5.3.5.4.1.)

h. Remove the test battery, and unkey the transmitter.

i. Reverse the test battery so the positive terminal is grounded and the negative terminal is connected to P203-2. Reset the 1-megohm potentiometer for minimum voltage on the vtvm.

j. Repeat steps f and g. The indication should be between -0.1 and -0.15 volt d-c.

5.2.2.6 LOADING SERVO-AMPLIFIER TEST. Perform the following operations:

a. Maintain the equipment setup established in paragraph 5.2.2.5.

b. Remove the front panel cover and remove relay K708. (Refer to figure 5-14.)

c. Connect the positive terminal of the 1.5-volt test battery through a 1-megohm potentiometer to terminal 1 of test point 5 (P203), and connect the negative terminal to ground. Set the 1-megohm potentiometer for minimum voltage on the vtvm.

d. Turn the power on and allow time for warmup.

e. Manually key the transmitter, and slowly increase the voltage applied to P203-1 by varying the 1-megohm potentiometer.

f. Observe r-f autotransformer T301. At the point where r-f autotransformer T301 starts moving, note the indication on the vtvm. The indication should be between 0.1 and 0.15 volt d-c.

g. Unkey the transmitter and reverse the polarity of the test battery. Reset the 1-megohm potentiometer for minimum voltage on the vtvm.

h. Manually key the transmitter, and repeat the test outlined in steps e and f. The indication should be between -0.1 and -0.15 volt d-c.

i. Unkey the transmitter and replace relay K708.

j. Repeat the tests outlined in steps e through h. The indication should be between 0.29 and 0.4 volt d-c for each polarity of the test battery.

k. Unkey the transmitter and remove relay K708.

l. Connect the test battery and 1-megohm potentiometer as outlined in step c.

m. Adjust the voltage at P203-1 to 0.5 volt d-c with the vtvm.

n. Manually key the transmitter.

o. Adjust the vtvm to the 30-volt a-c range, and connect between pin 1 of V603 (test point 6) and ground.

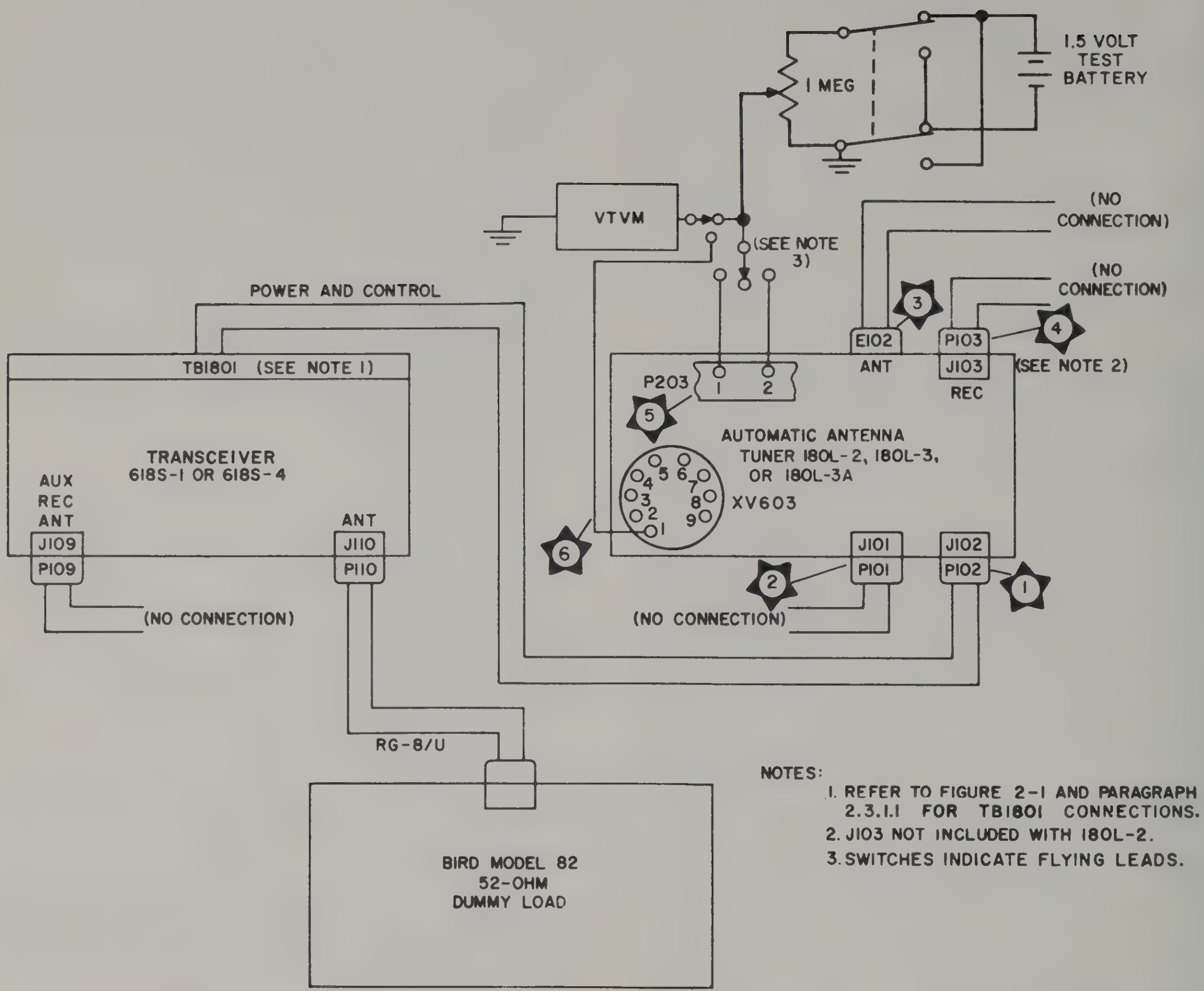


Figure 5-7. Servo-Amplifier Test Setup

(Refer to figure 5-8.) The indication should be not less than 20 volts a-c.

p. Unkey the transmitter, and manually position r-f autotransformer T301 to the maximum position (roller away from the front panel).

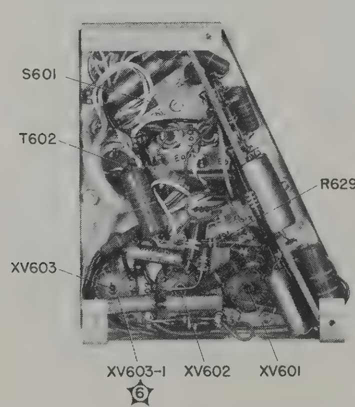


Figure 5-8. Servo-Amplifier Subassembly, Test Point Location

q. Adjust the voltage at P203-1 to 0.5 volt d-c with the vtvm. Observe the time required for the roller of T301 to go from maximum to minimum. The time required should not exceed 10 seconds.

5.2.2.7 SERVO-AMPLIFIER AVC TEST. Perform the following operations:

a. Perform steps b through e of paragraph 5.3.1.1.

b. Complete the test connections as indicated in figure 5-9. (The servo-amplifier dust cover should be on during this test.)

c. Turn the power on and allow sufficient time for warmup.

d. Rotate the channel selector to a position corresponding to a frequency of 18 to 22 megacycles.

e. Observe the tuning cycle of the antenna tuner.

f. The tuning elements should find a tuning point and remain stable during voice transmission in the 18- to 22-megacycle range when a representative antenna is being used. (If the tuning elements hunt under these conditions, refer to paragraph 5.3.5.4.2.)

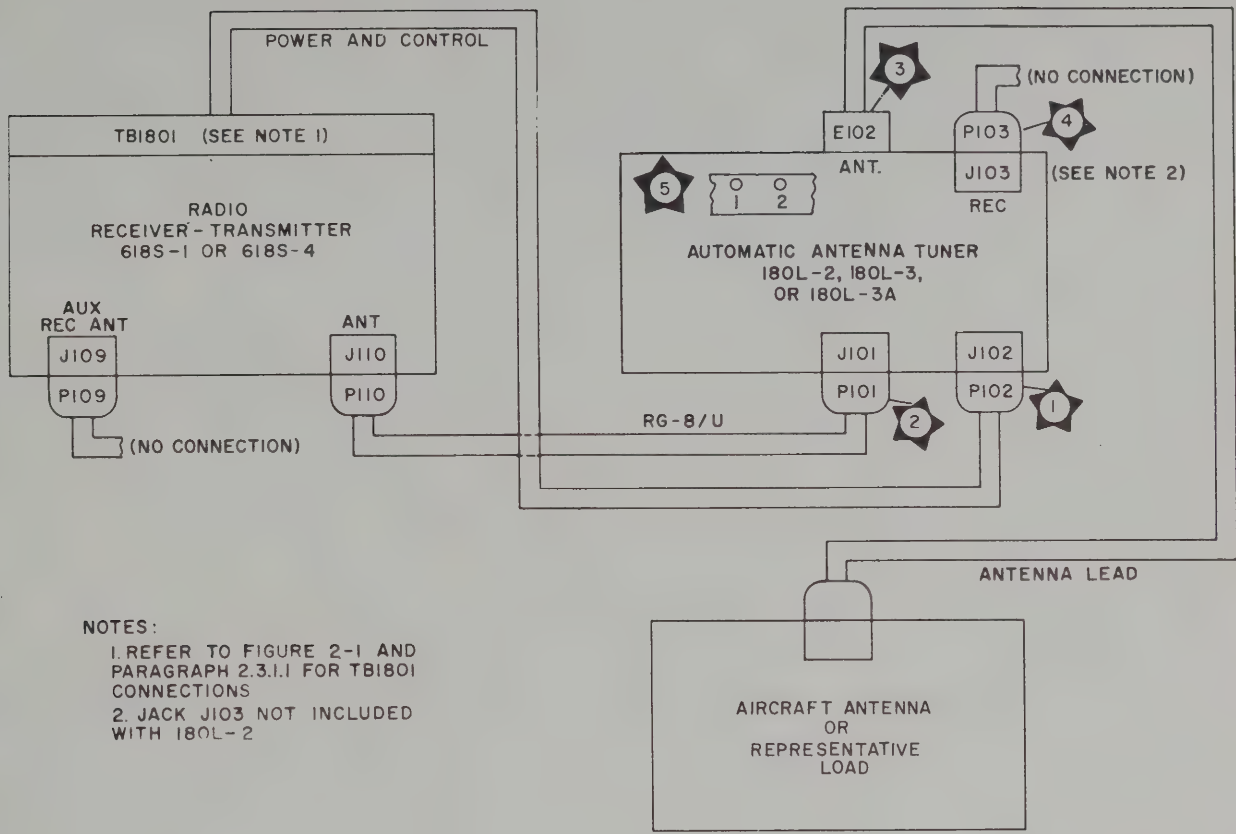


Figure 5-9. Servo-Amplifier Test Setup, AVC Test

5.3 CORRECTIVE MAINTENANCE.

When it has been determined that Automatic Antenna Tuner 180L-2 is not operating correctly, system trouble analysis must be performed. The purpose of the system trouble analysis is to determine quickly the subassembly in which trouble exists and to point out some of the most likely causes of trouble. When the trouble has been so analyzed, maintenance personnel can determine what action should be taken to correct the trouble depending upon the time element involved. To prevent excessive delays, those subassemblies which are defective should be exchanged for subassemblies known to be in good operating condition.

Trouble-isolation procedures are provided to aid in locating the trouble to a detailed part or simple circuit within a subassembly, and overhaul and repair procedures are provided for trouble correction. A detailed alignment and tracking procedure is provided in paragraph 5.3.5. Alignment and tracking procedures should not be attempted unless it has been established that a malfunction exists because a subassembly is misaligned. However, in cases where complete disassembly is necessary for trouble correction, alignment procedures must be performed.

5.3.1 SYSTEM TROUBLE ANALYSIS.

The following tests are used to locate trouble in Automatic Antenna Tuner 180L-2 to a subassembly. The test equipment listed in table 2-1 or equipment of equal or superior characteristics must be used to perform these tests. Refer to paragraph 5.3.2 for instructions concerning the removal and replacement of subassemblies.

5.3.1.1 TEST BENCH SETUP. Perform the following operations:

a. Remove the dust cover and front panel cover.

b. Set the antenna tuner on its side and observe terminal board TB704. TB704 should be connected for automatic keying and 250 volts B-plus. If TB704 is not connected as indicated in A of figure 2-4, remove the transparent cover, and connect the shorting straps correctly.

c. If the 180L-2 is being tested, terminals 2 and 4 of relay K1501 of the 618S-1 or 618S-4 Transceiver should be jumpered. If the 180L-3 or 180L-3A is being tested, these terminals should be disconnected.

d. Connect the associated test equipment, transceiver 618S-1 or 618S-4 plus accessories, in a test bench harness as illustrated in figure 2-1. Do not connect the primary power sources until ready to perform the test procedures.

e. Connect the antenna tuner power and control cable as illustrated in figure 2-1. In the test setup, the P102 terminals should be brought out to a terminal board to serve as test points. (Refer to figure 5-10.)

f. Do not connect the ANT connector until told to do so in table 5-2.

g. Do not connect the 180L-3 or 180L-3A REC connector until told to do so in table 5-2.

h. Terminate the r-f output cable, RG-8/U, of Transceiver 618S-1 or 618S-4 in the 52-ohm dummy load.

i. Proceed with the tests in table 5-2.

NOTE

When relays are removed and replaced during trouble-isolation procedures, each relay removed should be identified in some manner for replacement in the socket from which removed. If relays are intermixed while removed, false indications may result during the trouble-shooting procedures.

WARNING

The r-f and d-c voltages encountered in this unit are dangerous to life. Special care should be taken to avoid contact with the antenna lead-in and the r-f line. Also, all detail parts and wiring carrying B-plus voltages should be avoided. Before removing or replacing subassemblies or parts during trouble-shooting procedures, the primary power source switches should be turned off.

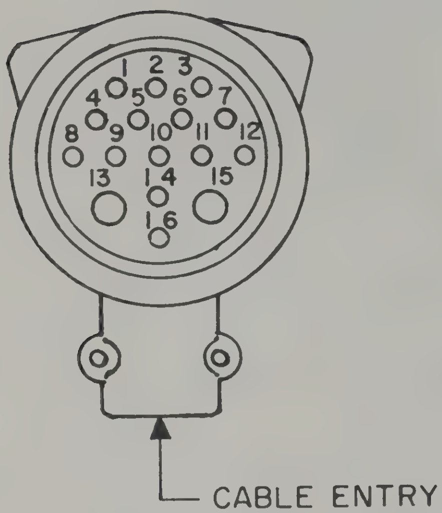


Figure 5-10. Plug P102 (Test Point 1), Terminal Location

TABLE 5-2. SYSTEM TROUBLE ANALYSIS

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
1	Visual	None	Turn the primary power on. Observe tubes V601, V602, and V603. (It may be necessary to remove the cover from the servo-amplifier subassembly.)	Tube filaments light.	Proceed to step 5.	Proceed to step 2.
2	1	VTVM, Hewlett-Packard 410B	Measure the voltage at terminal 13 of test point 1 (P102).	27.5 volts d-c.	Proceed to step 3.	Trouble is in cabling between antenna tuner and power supply.
3	Tube Tester		Check tubes in tube tester.	Tubes check good.	Proceed to step 4.	Replace defective tube (s).

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
4	Visual	None	Replace the servo-amplifier subassembly and observe tubes.	Tube filaments light.	Trouble is in original servo-amplifier subassembly.	Trouble is in cabling between P102 and servo-amplifier subassembly.
5	Oral	None	Select a new channel by rotation of the channel selector and check for automatic keying.	Transmitter remains keyed for 50 seconds ±5 seconds.	Proceed to step 8.	Proceed to step 6.
6	1	Multimeter, Simpson 260	Turn the power off and allow the 180L-2 to cool for approximately ten minutes. Measure for continuity between terminal 9 of test point 1 (P102) and ground during the test outlined in step 5.	Zero resistance.	Trouble is in external cabling.	Proceed to step 7.
7	Oral	None	Replace relays K707 and K708, and repeat the test outlined in step 5.	Same as step 5.	Trouble is in original relay(s). Determine defective relay(s) by substitution and replace.	Relay K711 defective or trouble is in cabling between P102 and relays or between relays.
8	2	None	Turn the power off and replace the front panel cover. Loosen the setscrew of E408 and remove the lead. (Refer to figure 5-11 and 5-12.) Manually rotate T301 until roller E303 is approximately three turns from maximum. Disconnect the RG-8/U cable	Roller E303 of T301 should run to the center tap position (plus or minus one turn) and stop. The center tap position is identifiable by the separation point of the two T301 windings. Variable inductor L401 should run to	Proceed to step 18.	Proceed to step 9.

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
8 (Cont)			from the dummy load and connect to J101 (test point 2). Turn the power on and allow time for warmup. Rotate the channel selector to the position corresponding to 2.0 megacycles.	minimum (all of the tape on the metal drum). Variable capacitor C501 should run to minimum (bellows in the downward position). Variable capacitor L401 should run six turns from minimum (six turns on the ceramic drum). Variable capacitor C501 would run to maximum (bellows in the upward position). Variable inductor L401 would run to maximum (all the tape on the ceramic drum). Relay K710 should be energized, driving contact E701 to the contact of shunt capacitor C101. The mechanical cycle should repeat as outlined above with K710 energized. Time-delay relay K711 should open between 30 and 55 seconds after channel selection causing all motion to stop.		
9	1	VTVM Hewlett-Packard 410B	Measure the voltage at terminals 2, 8, 11, 12, 13, and 14 of test point 1 (P102).	P102-2, 27.5 volts d-c; P102-8, 115 volts a-c; P102-11, P102-12, and P102-13, 27.5 volts d-c; P102-14, 250 volts d-c.	Proceed to step 10.	Trouble is in external cabling.

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
10	1 2	None	Replace relays K701 through K709, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in one or more of the original relays. Determine defective relay(s) by substitution and replace.	Proceed to step 11.
11	1 2	None	Replace tubes V601, V602, V603, and repeat the tuning test outlined in step 8.	Same as step 8.	Tube(s) is defective. Determine defective tube(s) by substitution and replace.	Proceed to step 12.
12	1 2	None	Replace chopper G601, and repeat the tuning test outlined in step 8.	Same as step 8.	Original G601 is defective.	Proceed to step 13.
13	1 2	None	Replace the variable inductor subassembly, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in original variable inductor subassembly.	Proceed to step 14.
14	1 2	None	Replace the variable capacitor subassembly, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in original variable capacitor subassembly.	Proceed to step 15.
15	1 2	None	Replace the r-f autotransformer subassembly, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in original r-f autotransformer subassembly.	Proceed to step 16.
16	1 2	None	Replace the servo amplifier subassembly, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in original servo-amplifier subassembly.	Proceed to step 17.

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
17	1 2	None	Replace the discriminator subassembly, and repeat the tuning test outlined in step 8.	Same as step 8.	Trouble is in original discriminator subassembly.	Trouble is in internal cabling or relay K710. If trouble cannot be found, replace main chassis.
18	3	Multimeter, Simpson 260	The following test should be performed on the 180L-3 and 180L-3A only. Momentarily turn the power off to stop all movement in the unit. Manually key the transmitter and measure for continuity between E102 (test point 3) and E507. (Refer to figure 5-12.)	Zero resistance.	Proceed to step 19.	E703 or K712 defective.
19	1 3	None	Turn the power off and replace the lead in E408. (Refer to figures 5-1 and 5-2.) Connect E102 (test point 3) to an ungrounded straight-wire antenna between 45 and 100 feet in length. Do not connect cable RG-58/U to test point 4 (J103) at this time. Replace the dust cover. (The front panel cover also should be in place.) Turn the power on and allow (Cont)	The tuning indicator lamp of Radio Set Control 614C-2 should either light or go off during the tuning cycle, depending upon the external wiring, Transceiver 618S-1 or 618S-4 should be keyed automatically throughout the tuning cycle of the antenna tuner. The complete tuning cycle of the antenna tuner should not exceed 30 seconds. When (Cont)	Proceed to step 26.	Proceed to step 20.

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
19 (Cont)			time for warm-up. Rotate the channel selector to the positions corresponding to 2, 6, 12, 16, and 22 megacycles.	manually keying the transceiver after the tuning cycle is complete, the SWR meter on the antenna tuner should read below the red area and the front panel meter of the transceiver in the P.A. and PL. positions should read within the red area.		
20	1 3	None	Replace tubes V601, V602, and V603, and repeat the test outlined in step 19.	Same as step 19.	Tube(s) is defective. Determine defective tube(s) by substitution and replace.	Proceed to step 21.
21	1 3	None	Replace the variable inductor subassembly, and repeat the test outlined in step 19.	Same as step 19.	Trouble is in original variable inductor subassembly.	Proceed to step 22.
22	1 3	None	Replace the variable capacitor subassembly, and repeat the test outlined in step 19.	Same as step 19.	Trouble is in original variable capacitor subassembly.	Proceed to step 23.
23	1 5	None	Replace the r-f autotransformer subassembly, and repeat the test outlined in step 19.	Same as step 19.	Trouble is in original autotransformer subassembly.	Proceed to step 24
24	1 3	None	Replace the servo-amplifier subassembly, and repeat the test outlined in step 19.	Same as step 19.	Trouble is in original servo-amplifier subassembly.	Proceed to step 25.

TABLE 5-2. SYSTEM TROUBLE ANALYSIS (Cont)

STEP	TEST POINTS	TEST EQUIPMENT	CONTROL SETTINGS AND ADJUSTMENTS	NORMAL INDICATION	IF INDICATION IS NORMAL	IF INDICATION IS ABNORMAL
25	1 3	None	Replace the discriminator subassembly, and repeat the test outlined in step 19.	Same as step 19.	Trouble is in original discriminator subassembly.	Trouble is in the internal cabling, relay K710, or shunt capacitor C101. If trouble cannot be found, replace the main chassis.
26	3 4	Multimeter, Simpson 260	Turn the power off and measure the resistance between E102 (test point 3) and J103 (test point 4). (This test for 180L-3 and 180L-3A only.)	Zero resistance.		Relay K712 defective.

5.3.2 REMOVAL AND REPLACEMENT OF SUBASSEMBLIES.

Automatic Antenna Tuner 180L-2 consists of a group of five subassemblies and the main chassis. Paragraphs 5.3.2.1 through 5.3.2.6 describe the correct method of removing the subassemblies, tubes, and chopper G601. Paragraph 5.3.2.7 describes the correct method of replacing the subassemblies. It is assumed throughout the following instructions that it is only desired to remove and replace one subassembly at a time, leaving as many as possible of the other subassemblies secured to the main chassis. If it is desired to remove all five of the subassemblies, access is more readily attainable, and it may be possible to omit some of the listed procedures. Refer to figures 5-11 through 5-16 throughout the removal and replacement instructions.

5.3.2.1 VARIABLE INDUCTOR SUBASSEMBLY. Perform the following operations:

a. Remove six Phillips-head screws and lock washers securing the dust cover and remove the dust cover. It is not necessary to remove the front panel cover.
b. Loosen the setscrews of E408 and E406 (1, figures 5-11 and 5-12) and remove the leads.
c. Remove five Phillips-head screws and lock washers (2, figure 5-15) and hold the variable inductor subassembly in place.
d. Push the variable inductor subassembly slightly to the rear and remove plug P401 from jack J401 (3, figure 5-16).
e. Lift the variable inductor subassembly free from the main chassis.

5.3.2.2 VARIABLE CAPACITOR SUBASSEMBLY. Perform the following operations:

a. Remove the variable inductor subassembly as outlined in paragraph 5.3.2.1.
b. Remove plug P501 from jack J501 (4, figures 5-11 and 5-12).
c. Loosen the setscrew of E507 (5, figures 5-11 and 5-12).
d. Remove six Phillips-head screws and lock washers (6, figure 5-15) and lift the variable capacitor subassembly free from the main chassis while removing the lead from E507.

5.3.2.3 R-F AUTOTRANSFORMER SUBASSEMBLY. Perform the following operations:

a. Remove six Phillips-head screws and lock washers securing the dust cover and remove the dust cover.
b. Remove five Phillips-head screws and lock washers securing the front panel cover and remove the front panel cover. (For the 180L-2, it also is necessary to loosen the setscrew of E507 to remove the front panel cover. Refer to figure 5-11.)
c. Loosen the setscrew of E408 (1, figures 5-11 and 5-12) and remove lead.
d. Remove plug P301 (7, figure 5-14) from jack J301.
e. Loosen the setscrew of E202 (8, figure 5-16) and remove lead.

f. Remove four Phillips-head screws (9 , figures 5-10, 5-11, and 5-16).

g. Work the r-f autotransformer subassembly free and remove from the main chassis.

5.3.2.4 SERVO-AMPLIFIER SUBASSEMBLY. Perform the following operations:

a. Remove six Phillips-head screws and lock washers securing the dust cover and remove the dust cover.

b. Remove five Phillips-head screws and lock washers securing the front panel cover and remove the front panel cover. (For the 180L-2, it also is necessary to loosen the setscrew of E507 to remove the front panel cover. Refer figure 5-11.)

c. Remove relays K701, K702, and K709. (Refer to figure 5-14.)

d. Remove the tube shields and tubes from the servo-amplifier subassembly.

e. Loosen the setscrew securing the chopper clamp, and remove G601 from the servo-amplifier subassembly. Chopper G601 is located next to tube V601.

f. Loosen the two Phillips-head screws located in the top holes of the servo-amplifier subassembly (10 , figures 5-11 and 5-12).

g. Remove two Phillips-head screws (11 , figures 5-11 and 5-12).

h. Lift the rear of the servo-amplifier subassembly to disengage plug P601 from jack J601.

i. Lift the rear and work the servo-amplifier subassembly free from the main chassis.

5.3.2.5 DISCRIMINATOR SUBASSEMBLY. Perform the following operations:

a. Remove the r-f autotransformer subassembly as outlined in paragraph 5.3.2.3.

b. Remove plug P201 (12 , figure 5-14) from jack J201.

c. Remove plug P203 (13 , figure 5-14) from jack J203.

d. Remove four Phillips-head screws and lock washers (14 , figure 5-15).

e. Lift the discriminator subassembly free from the main chassis.

5.3.2.6 TUBES AND CHOPPER. Perform the following operations:

a. Remove five Phillips-head screws and lock washers securing the front panel cover and remove the front panel cover. (For the 180L-2, it also is necessary to loosen the setscrew of E507 to remove the front panel cover. Refer to figure 5-11.)

b. Loosen the setscrew of the chopper clamp and remove the chopper clamp.

c. Remove chopper G601.

d. Remove relays K701, K702, and K709.

e. Remove tubes V601, V602, and V603.

5.3.2.7 REPLACEMENT OF SUBASSEMBLIES. Replacement of the 180L-2 subassemblies is accomplished by reversing the removal procedures. However, certain precautions should be taken during replacement operations that are not noted in the removal procedures. Steps a through c list the required precautions for replacing the 180L-2 subassemblies.

a. When engaging plugs or tubes, make certain the pins are not bent.

b. When replacing the servo-amplifier subassembly, make certain the 1/8-inch Phillips-head screws are replaced in the proper place. The servo-amplifier subassembly is silk screened for proper location of the 1/8-inch screws.

c. When replacing the variable inductor, variable capacitor, and discriminator subassemblies, make certain the subassembly is oriented properly with the silk-screen outline on the bottom of the main chassis.

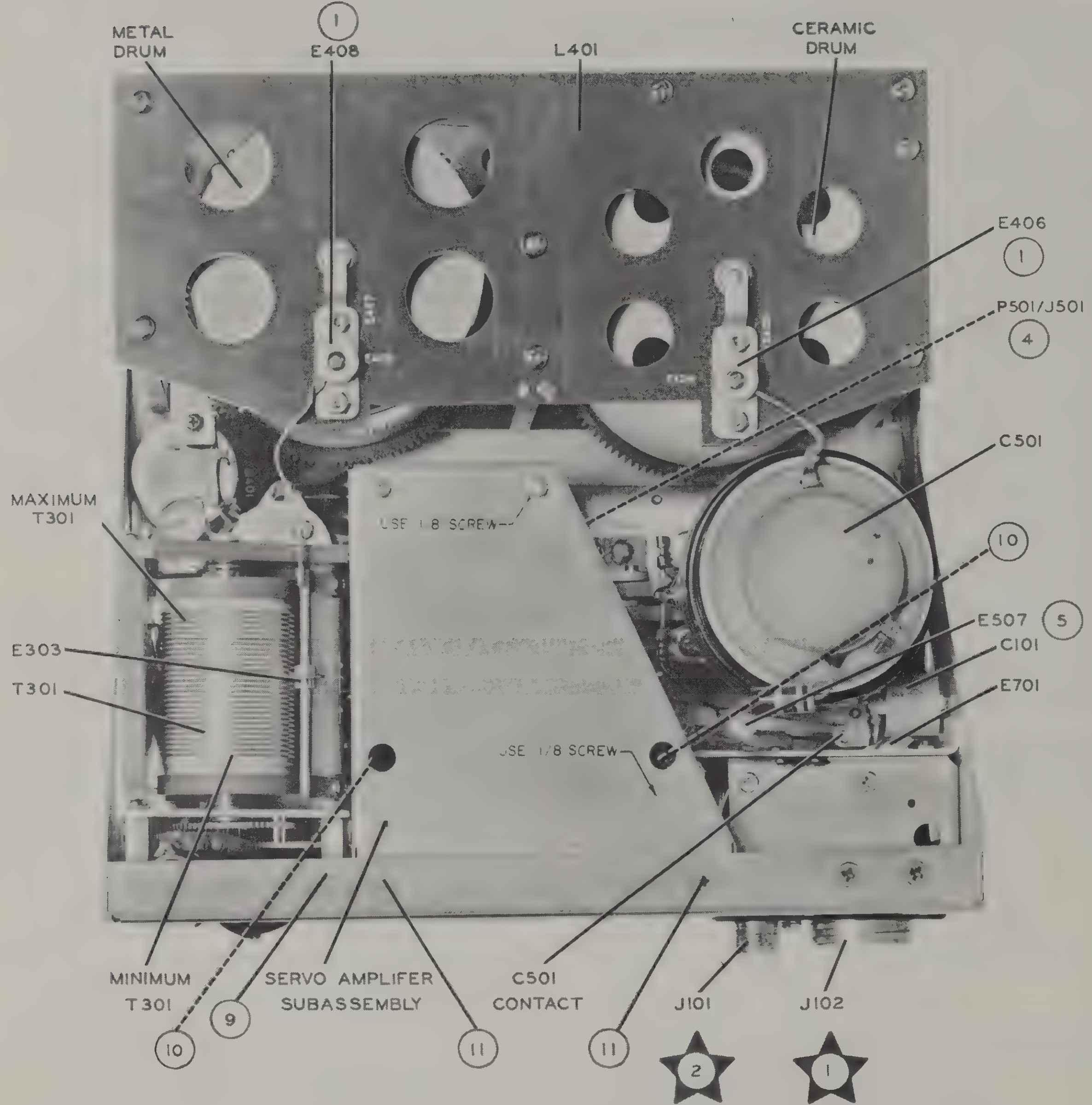
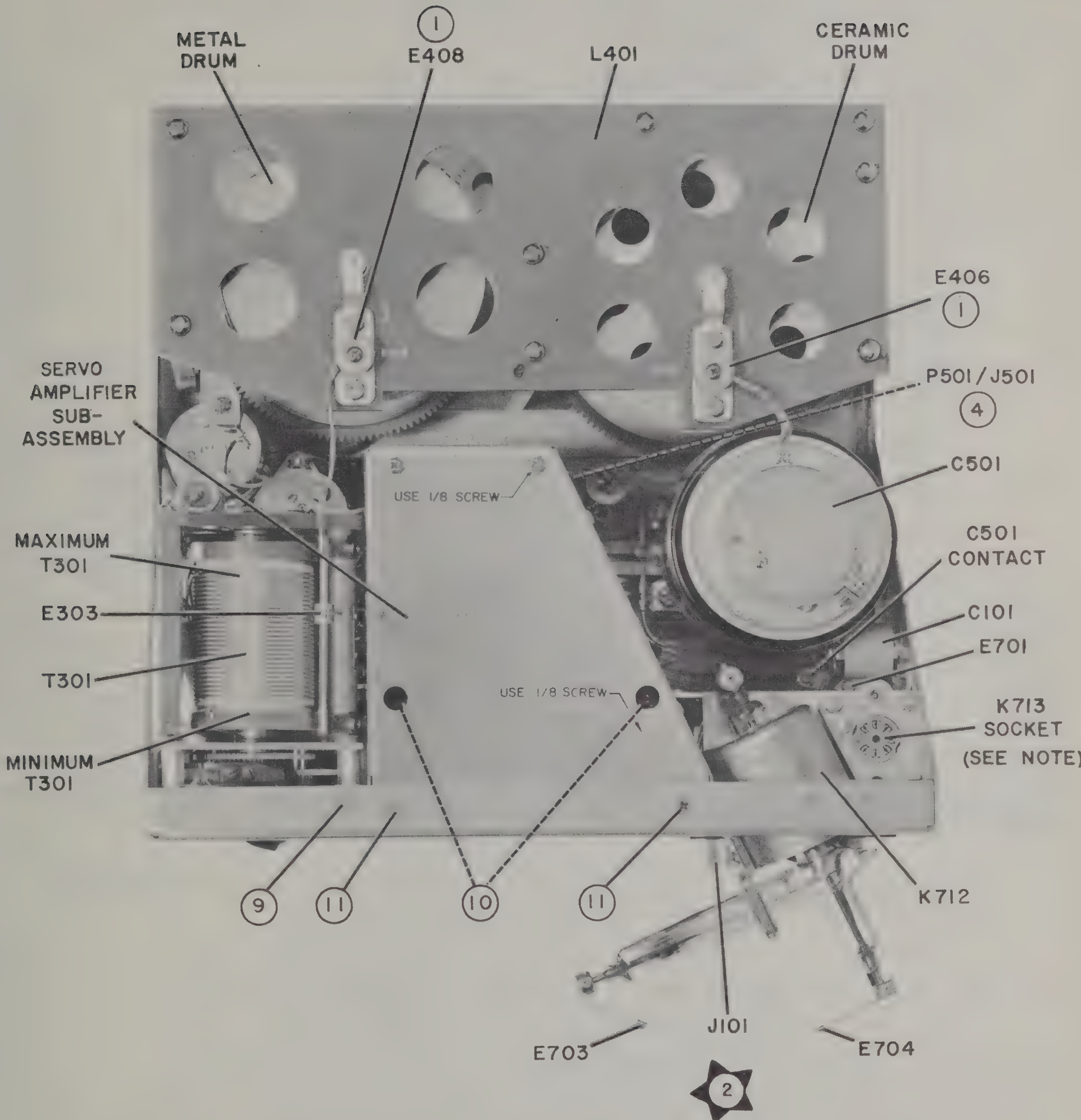
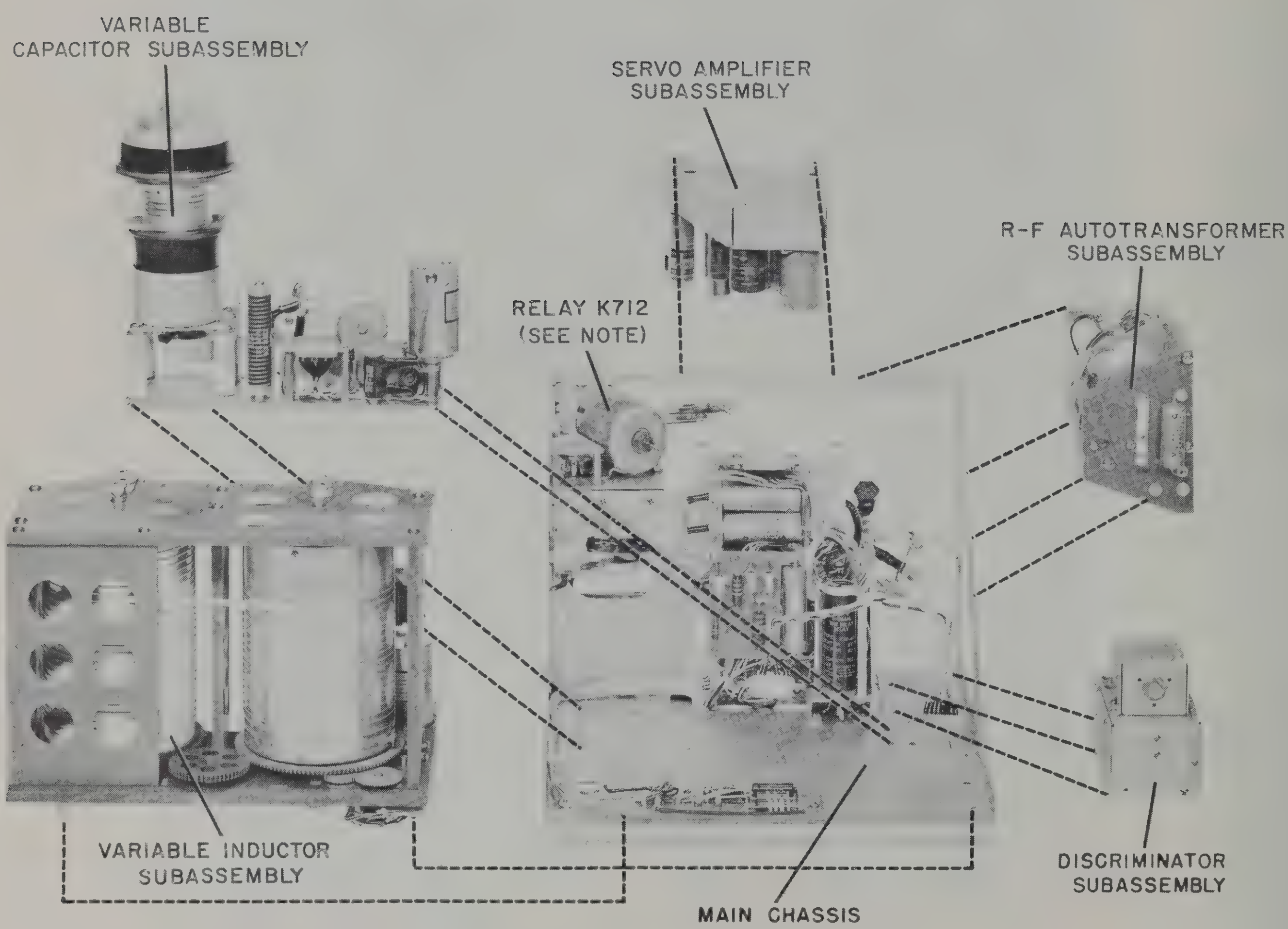


Figure 5-11. Automatic Antenna Tuner 180L-2, Top View with Front Panel and Dust Cover Removed



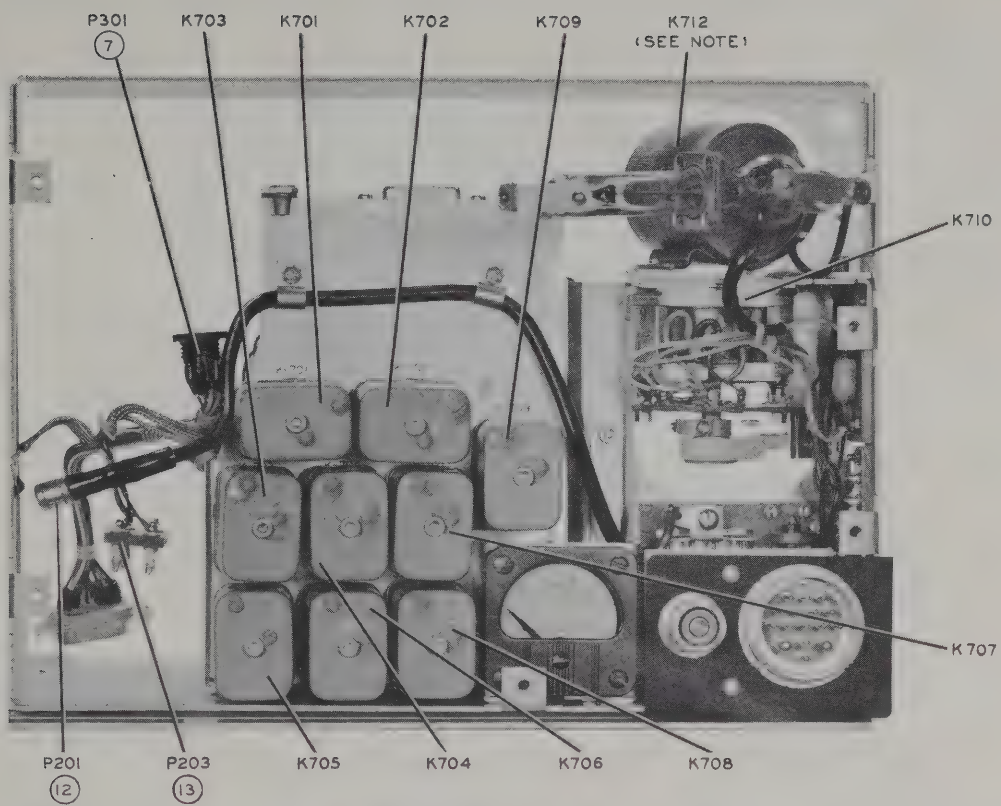
NOTE.
K713 INCLUDED ONLY WITH 180L-3A

Figure 5-12. Automatic Antenna Tuner 180L-3, Top View with Front Panel and Dust Cover Removed



NOTE: RELAY K712 NOT INCLUDED WITH AUTOMATIC ANTENNA TUNER 180L-2.

Figure 5-13. Automatic Antenna Tuner 180L-3, Subassemblies Exploded



NOTE: RELAY K712 NOT INCLUDED WITH AUTOMATIC ANTENNA TUNER 180L-2.

Figure 5-14. Automatic Antenna Tuner 180L-3, Front Panel, Covers and Subassemblies Removed

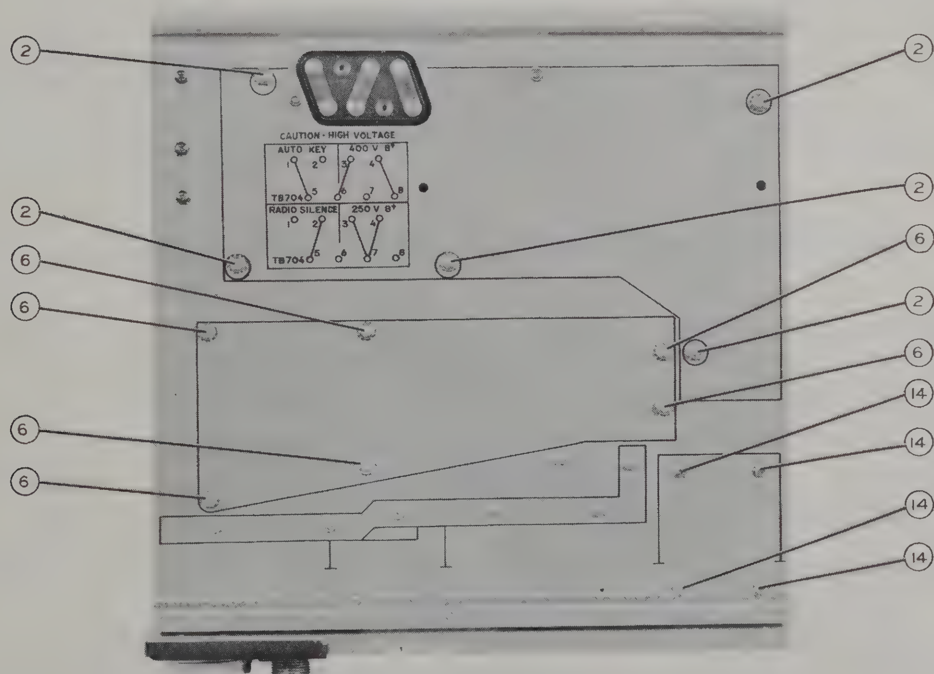


Figure 5-15. Main Chassis, Bottom View, Subassembly Removal Points

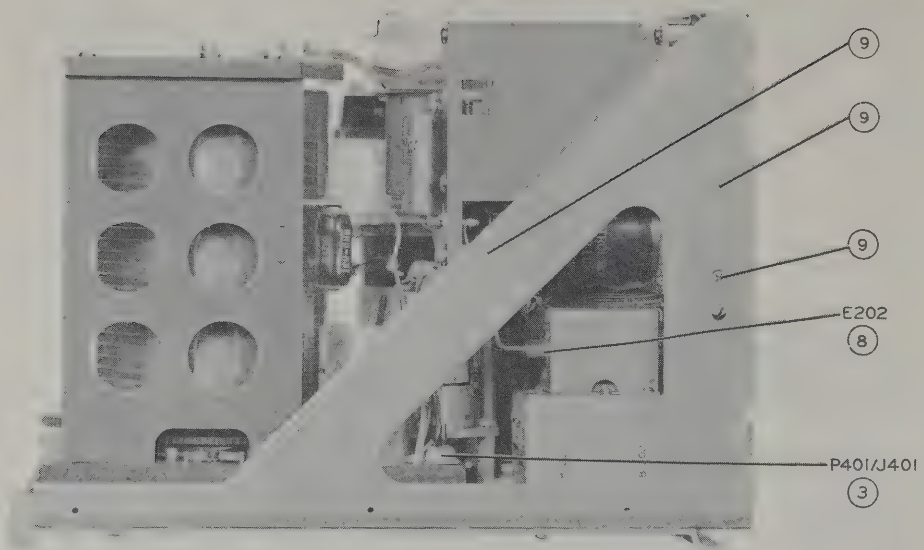


Figure 5-16. Main Chassis, Left Side View, Subassembly Removal Points

5.3.3 TROUBLE-ISOLATION PROCEDURES.

Trouble-isolation procedures for Automatic Antenna Tuner 180L-2 are used to determine which detailed part or group of detailed parts within a subassembly is defective. Before proceeding with the trouble isolation procedures which follow, the system trouble analysis in paragraph 5.3.1 should be performed to locate the trouble to a subassembly.

When the trouble has been located to a subassembly, that subassembly must be substituted in a unit known to be in good operating condition before starting the trouble-isolation procedures.

5.3.3.1 TROUBLE-ISOLATION TABLES. After the trouble has been located to a subassembly, and the subassembly has been substituted in a unit known to be in good operating condition, the preinstallation bench test in paragraph 2.3 and the operational check in paragraph 5.2.2 should be performed while observing any abnormal conditions or trouble symptoms. Reference then can be made to the trouble-isolation table of the subassembly under test for the suggested cause and remedy of the particular malfunction. When adjustment is called for as a suggested remedy, refer to paragraph 5.3.5. Resistance, voltage, and voltage distribution measurements are provided in paragraphs 5.3.3.2 through 5.3.3.6 for additional trouble shooting.

TABLE 5-3. DISCRIMINATOR SUBASSEMBLY, TROUBLE ISOLATION

Crystal rectifiers CR201 and CR202 comprise a matched pair. Crystal rectifiers CR203 and CR204 comprise a second matched pair. If any of the crystal rectifiers are defective, both the defective crystal rectifier and the matching crystal rectifier must be replaced.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. SWR indicator remains at high reading after channel selection.	1. Connector P201/J201 defective.	Replace or repair as necessary.
2. SWR indicator remains at high reading after the tuning cycle is complete.	1. Crystal rectifier CR201, CR202, CR203, or CR204 defective.	Replace defective crystal rectifier. (Use matched pair.)

TABLE 5-3. DISCRIMINATOR SUBASSEMBLY, TROUBLE ISOLATION (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
	2. Defective detail part within phasing discriminator circuit.	Replace defective detail part.
	3. Defective detail part within loading discriminator circuits.	Replace defective detail parts.
3. 180L-2 tunes continuously until relay K711 opens. T301 remains at the center tap position.	1. Connector P203/J203 defective.	Replace or repair as necessary.
	2. Crystal rectifier CR201 or CR202 defective.	Replace CR201 and CR202.
	3. Defective detail part within phasing discriminator circuit.	Replace defective detail part.
4. Avc circuit not functioning properly as determined by the test outlined in paragraph 5.2.2.7.	1. Connector P203/J203 defective.	Replace or repair as necessary.
	2. Crystal rectifier CR205 defective.	Replace CR205.
	3. Defective detail part within avc circuit.	Replace defective detail part.
5. Series tuning elements (L401 and C501) find a tuning point but T301 stops at minimum.	1. Crystal rectifier CR204 defective.	Replaces CR203 and CR204.
	2. Crystal rectifier CR204 reversed.	Reverse CR204 connections.
6. T301 runs toward maximum and stops at center tap. Series tuning elements find a tuning point. T301 runs to maximum and returns to center tap Series tuning elements again find a tuning point. T301 again runs to maximum and returns to center tap; cycle continues until K711 opens.	1. Connector P203/J203 defective.	Replace or repair as necessary.
	2. Crystal rectifier CR203 defective.	Replace CR203 and CR204.
	3. Crystal rectifier CR203 reversed.	Reverse CR203 connections.

TABLE 5-4. SERVO-AMPLIFIER SUBASSEMBLY, TROUBLE ISOLATION

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Filaments do not light.	1. Defective tube filament.	Locate and replace defective tube.
	2. Inductor L601 open.	Replace L601.
	3. Connector P601/J601 defective.	Replace or repair as necessary.

TABLE 5-4. SERVO-AMPLIFIER SUBASSEMBLY, TROUBLE ISOLATION (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
2. SWR indicator remains at high reading after tuning cycle is complete or 180L-2 tuning circuits fail to operate.	1. Tube V601, V602, or V603 defective.	Replace defective tube.
	2. Connector P601/J601 defective.	Replace or repair as necessary.
	3. Motor B601 defective.	Replace motor B601.
	4. Chopper G601 defective.	Replace chopper G601.
	5. Transformer T601 or T602 defective.	Replace defective transformer.
	6. Detail part of phasing servo-amplifier circuit defective.	Replace defective detail part.
	7. Detail part of loading servo-amplifier circuit defective.	Replace defective detail part.
3. 180L-2 tunes continuously until relay K711 opens.	1. Tube V601, V602, or V603 defective.	Replace defective tube.
	2. Connector P601/J601 defective.	Replace or repair as necessary.
	3. Motor B601 defective.	Replace motor B601.
	4. Chopper G601 defective.	Replace chopper G601.
	5. S601 defective.	Replace or adjust defective switch.
	6. Transformer T602 defective.	Replace defective transformer.
	7. Detail part of phasing servo-amplifier circuit defective.	Replace defective detail part.
4. Avc circuit not functioning properly as determined by the test outlined in paragraph 5.2.2.7.	1. Connector P601/J601 defective.	Replace or repair as necessary.
	2. Resistor R629 incorrect value.	Select correct value of R629 and replace. Refer to paragraph 5.3.5.4.2.

TABLE 5-5. R-F AUTOTRANSFORMER SUBASSEMBLY, TROUBLE ISOLATION

SYMPTOM	PROBABLE CAUSE	REMEDY
1. SWR indicator remains at high reading after tuning cycle is complete.	1. Motor B301 defective.	Replace motor B301.

TABLE 5-5. R-F AUTOTRANSFORMER SUBASSEMBLY, TROUBLE ISOLATION (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
2. 180L-2 tunes continuously until relay K711 opens.	1. Connector P301/J301 defective.	Replace or repair as necessary.
	2. Motor B301 defective.	Replace motor B301.
	3. R-f autotransformer T301 defective.	Replace T301.
	4. Switch S303 or S304 defective.	Replace or adjust defective switch.
3. T301 runs toward maximum and stops at center tap. Series tuning elements find a tuning point. T301 runs to maximum and returns to center tap. Series tuning elements again find a tuning point. T301 again runs to maximum and returns to center tap. Cycle continues until K711 opens.	1. Connector P301/J301 defective.	Replace or repair as necessary.
	2. Switch S304 defective.	Replace or adjust defective switch.
4. Motor B301 fails to run.	1. Connector P301/J301 defective.	Replace or repair as necessary.
	2. Motor B301 defective.	Replace motor B301.

TABLE 5-6. VARIABLE INDUCTOR SUBASSEMBLY, TROUBLE ISOLATION

SYMPTOM	PROBABLE CAUSE	REMEDY
1. 180L-2 tunes continuously until relay K711 opens.	1. Variable inductor L401 open or shorted.	Replace L401.
	2. Connector E405, E406, E407, or E408 defective.	Repair as necessary.
2. Motor B401 fails to run.	1. Connector P401/J401 defective.	Replace or repair as necessary.
	2. Switch S401A, S401B, S402A, or S402B defective.	Replace defective switch.
	3. Resistor R401 open.	Replace R401.
	4. Motor B401 defective.	Replace B401.
3. Relay K710 is not energized when L401 reaches maximum.	1. Connector P401/J401 defective.	Replace or repair as necessary.
	2. Switch S402A defective.	Replace or adjust switch S402.

TABLE 5-6. VARIABLE INDUCTOR SUBASSEMBLY, TROUBLE ISOLATION (Cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
4. 180L-2 circuits do not function correctly as determined by mechanical cycle tests, paragraph 5.2.2.1.	1. Connector P401/J401 defective.	Replace or repair as necessary.
	2. Switch S401A, S401B, S402A, or S402B defective.	Replace or adjust defective switch.
	3. Mechanical linkage between B401 and switches defective.	Repair as necessary.
	4. Motor B401 defective.	Replace B401.

TABLE 5-7. VARIABLE CAPACITOR SUBASSEMBLY, TROUBLE ISOLATION

SYMPTOM	PROBABLE CAUSE	REMEDY
1. 180L-2 tunes continuously until relay K711 opens.	1. Variable capacitor C501 defective.	Replace C501.
	2. R-f line within variable capacitor subassembly open.	Repair as necessary.
2. Motor B501 fails to run.	1. Connector P501/J501 defective.	Replace or repair as necessary.
	2. Resistor R501 defective.	Replace R501.
	3. Motor B501 defective.	Replace B501.
	4. Switch S501 or S502 defective.	Replace or adjust defective switch.
3. 180L-2 circuits do not function correctly as determined by mechanical cycle tests, paragraph 5.2.2.1.	1. Connector P501/J501 defective.	Replace or repair as necessary.
	2. Resistor R501 defective.	Replace R501.
	3. Motor B501 defective.	Replace B501.
	4. Switch S501 or S502 defective.	Replace or adjust defective switch.
	5. Internal wiring of variable capacitor subassembly defective.	Repair as necessary.

5.3.3.2 RESISTANCE MEASUREMENTS. Table 5-8 lists typical resistance measurements for tubes V601, V602, and V603 and chopper G601. These resistance values are intended for trouble-shooting procedures and are not intended to be absolutely correct in measurement. Variations from the given values may occur with the equipment still in good operating condition. When making the resistance measurements, the equipment should be disconnected, and the main chassis dust cover and servo-amplifier cover removed. The

resistance measurements should be made between the tube or chopper pins and ground. All resistance values are listed in ohms.

5.3.3.3 VOLTAGE MEASUREMENTS. Table 5-9 lists typical voltage measurements for tubes V601, V602, and V603 and chopper G601. These voltage values are intended for trouble-shooting procedures and are not intended to be absolutely correct in measurement. Variations from the given values may occur with the equipment still in good operating condition. When making the voltage measurements, the equipment should be connected to a test bench harness, as illustrated in figure 2-1, and the main chassis dust cover

TABLE 5-8. RESISTANCE MEASUREMENTS

PIN	V601	V602	V603	G601
TB704 CONNECTED FOR 250 VOLTS B-PLUS				
1	Infinity	Infinity	Infinity	450K or 0
2	470K	470K	220K	0
3	0	100	31	1
4	34	28	25	1
5	34	28	25	0
6	Infinity	Infinity	Infinity	600K or 0
7	68K	485K to 522K	470K	0
8	0	100	1000	-
9	31	31	28	-
TB704 CONNECTED FOR 400 VOLTS B-PLUS				
1	480K	260K	40K	450K or 0
2	470K	470K	220K	0
3	0	100	31	1
4	34	28	25	1
5	34	28	25	0
6	500K	280K	65K	600K or 0
7	470K	485K to 552K	470K	0
8	0	100	1000	-
9	31	31	28	-

and servo-amplifier subassembly cover removed. The measurements should be made between tube or chopper pins and ground. The transmitter should be unkeyed for all measurements, and all voltages are d-c.

5.3.3.4 VOLTAGE DISTRIBUTION, 27.5-VOLT D-C LINE. Figure 5-17 illustrates the distribution of the 27.5-volt d-c supply line. The distribution should be as indicated in figure 5-17 after tuning operations are complete, and all movement in the 180L-2 has ceased. When trouble-shooting the 180L-2, the 27.5-volt d-c line may be traced through the indicated terminals and contacts. Tube socket adapters should be used to facilitate measurement of voltages on the relay and tube contacts. Connect the 180L-2 in a test bench set-up in accordance with steps a through i before performing the 27.5-volt d-c distribution checks.

a. Remove the dust cover and front panel cover.

b. Set the 180L-2 on its side and observe terminal board TB704. When the test setup includes Transceiver 618S-1 or Transceiver 618S-4, the 180L-2 should be connected for 250 volts B-plus. If TB704 is not connected as indicated in A or B of figure 2-4, remove the transparent cover and connect the shorting straps correctly.

TABLE 5-9. VOLTAGE MEASUREMENTS

PIN	V601	V602	V603	G601
TB704 CONNECTED FOR 250 VOLTS B-PLUS				
1	55	180	250	0
2	-0.54	0	0	0
3	0	2.6	21.2	0
4	27.5	14.9	8.6	0
5	27.5	14.9	8.6	0
6	50	175	245	0
7	-0.54	0	0	0
8	0	2.6	8.9	-
9	21.2	21.2	14.9	-
TB704 CONNECTED FOR 400 VOLTS B-PLUS				
1	65	200	300	0
2	-0.44	0	0	0
3	0	2.6	21.2	0
4	27.5	14.9	8.6	0
5	27.5	14.9	8.6	0
6	55	175	250	0
7	-0.44	0	0	0
8	0	2.6	8.9	-
9	21.2	21.2	14.9	-

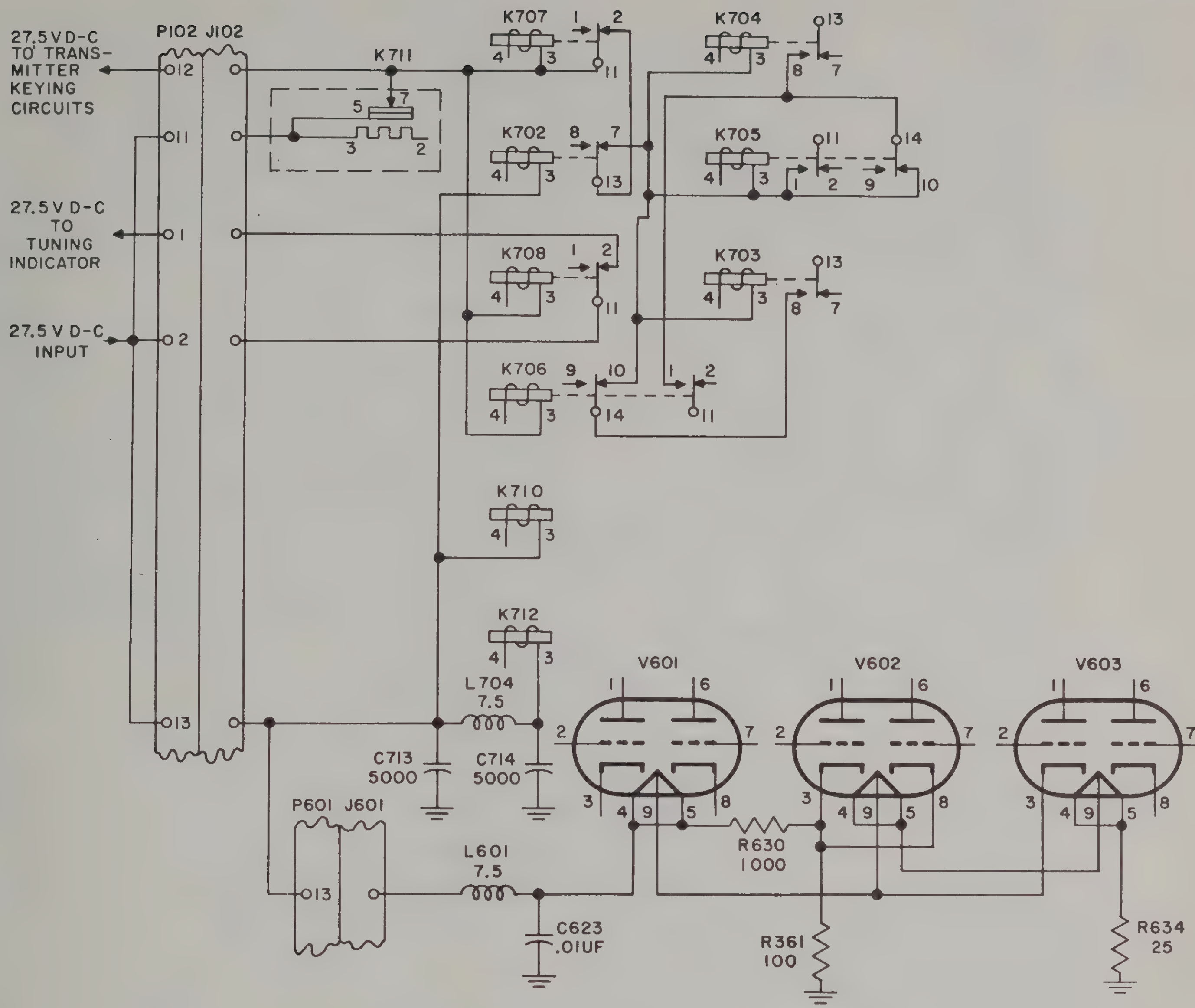


Figure 5-17. Voltage Distribution, 27.5-Volt D-C Line

c. If the 180L-2 is being tested, terminals 2 and 4 of relay K1501 of the 618S-1 or 618S-4 should be jumpered. If the 180L-3 is being tested, these terminals should be disconnected.

d. Connect the associated test equipment Transceiver 618S-1 or 618S-4) in a test bench harness as illustrated in figure 2-1. Do not connect to the primary power sources until ready to perform the test procedures.

e. Connect the 180L-2 power and control cable as illustrated in figure 2-1. In the test setup, the P102 terminals should be brought out to a terminal board to serve as test points.

f. Terminate the r-f output cable (RG-8/U) of Transceiver 618S-1 or 618S-4 in the 52-ohm dummy load.

g. Connectors J101, E102, and J103 should be unterminated.

h. Set the transmitter to the key-up position.

i. Turn the power on and proceed to the 27.5-volt d-c distribution checks.

5.3.3.5 VOLTAGE DISTRIBUTION, 115-VOLT, 400-CPS LINE. Figure 5-18 illustrates the distribution of the 115-volt, 400-cps supply line. The distribution should be as indicated in figure 5-18 after tuning operations are complete and all movement in the 180L-2 has ceased. When trouble-shooting the 180L-2, the 115-volt, 400-cps line may be traced through the indicated terminals and contacts. Connect the 180L-2 or 180L-3 in a test bench setup in accordance with steps a through i of paragraph 5.3.3.4 before performing the 115-volt 400-cps distribution checks.

5.3.3.6 B-PLUS VOLTAGE DISTRIBUTION. Figure 5-19 illustrates the distribution of the B-plus supply

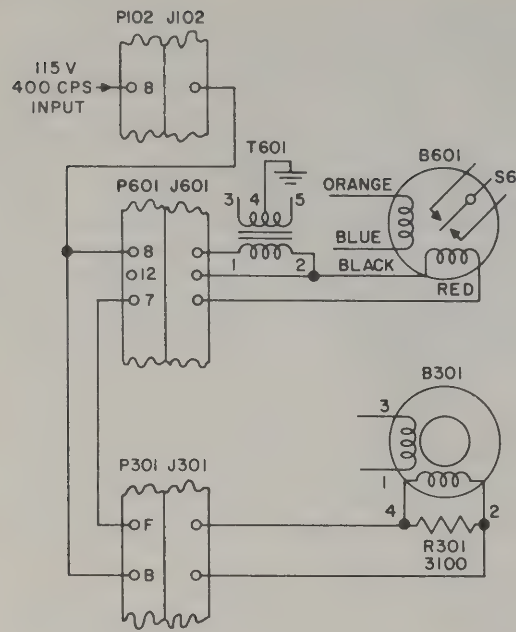
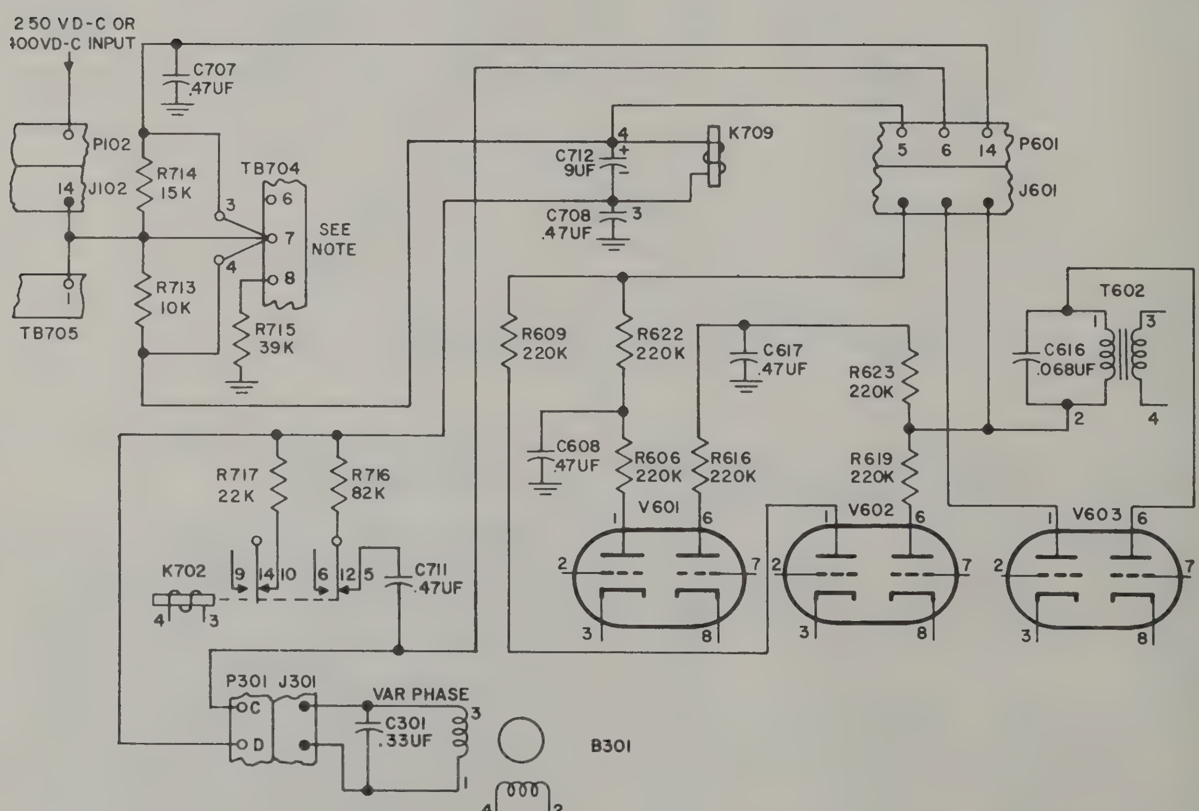


Figure 5-18. Voltage Distribution, 115-Volt, 400-CPS Line

line. The distribution should be as indicated in figure 5-19 after tuning operations are complete and all movement in the 180L-2 has ceased. When troubleshooting the 180L-2, the B-plus line may be traced through the indicated terminals and contacts. Tube socket adapters should be used to facilitate measurement of voltages on the relay and tube contacts. Connect the 180L-2 or 180L-3 in a test bench setup in accordance with steps a through i of paragraph 5.3.3.4 before performing the B-plus voltage distribution checks.

5.3.4 OVERHAUL AND REPAIR.

In order to facilitate replacement of any part contained in the variable inductor, variable capacitor, or r-f autotransformer subassemblies, disassembly procedures are outlined in the following paragraphs. Because reassembly is accomplished by reversing the disassembly procedures, no special instructions are given for reassembly. When the subassemblies are disassembled, all parts are available for cleaning, inspection, lubrication, and replacement. Cleaning procedures are listed in paragraph 5.3.4.5, and inspection procedures are listed in paragraph 5.3.4.6. For lubrication procedures, reference should be made to paragraph 5.2.1.



NOTE: TB704 IS SHOWN FOR 250-VOLT B-PLUS OPERATION. FOR 400-VOLT B-PLUS OPERATION, TB704-3 CONNECTS TO TB704-6 AND TB704-4 CONNECTS TO TB704-B.

Figure 5-19. Voltage Distribution, B-Plus Line

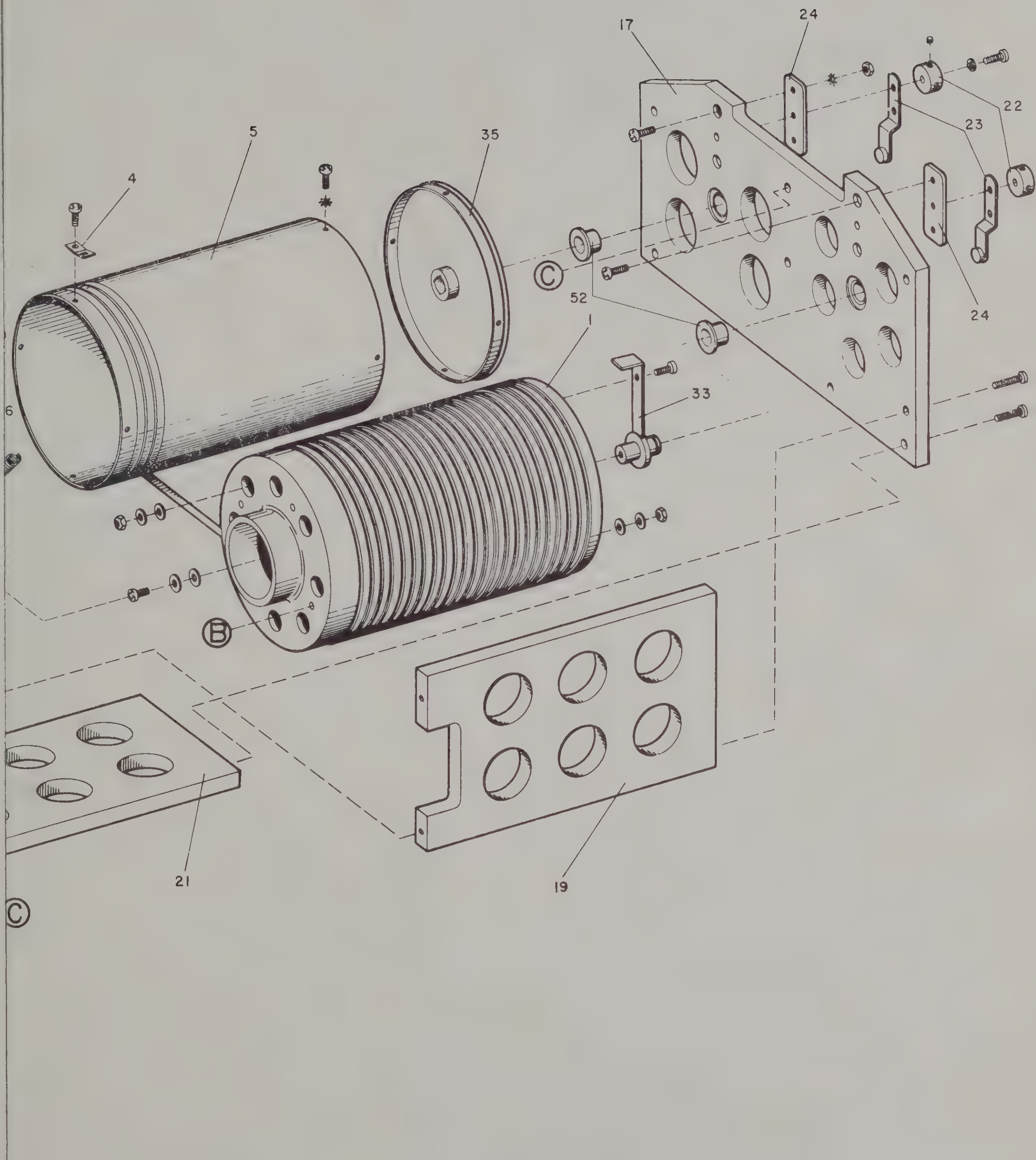


Figure 5-20. Variable Inductor Subassembly, Exploded View

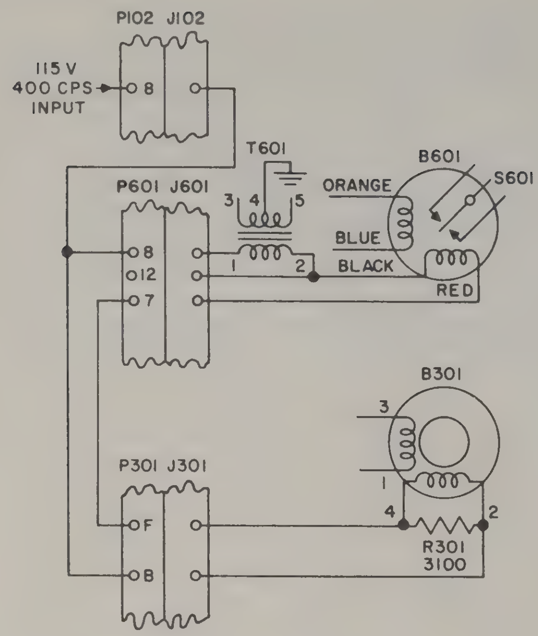
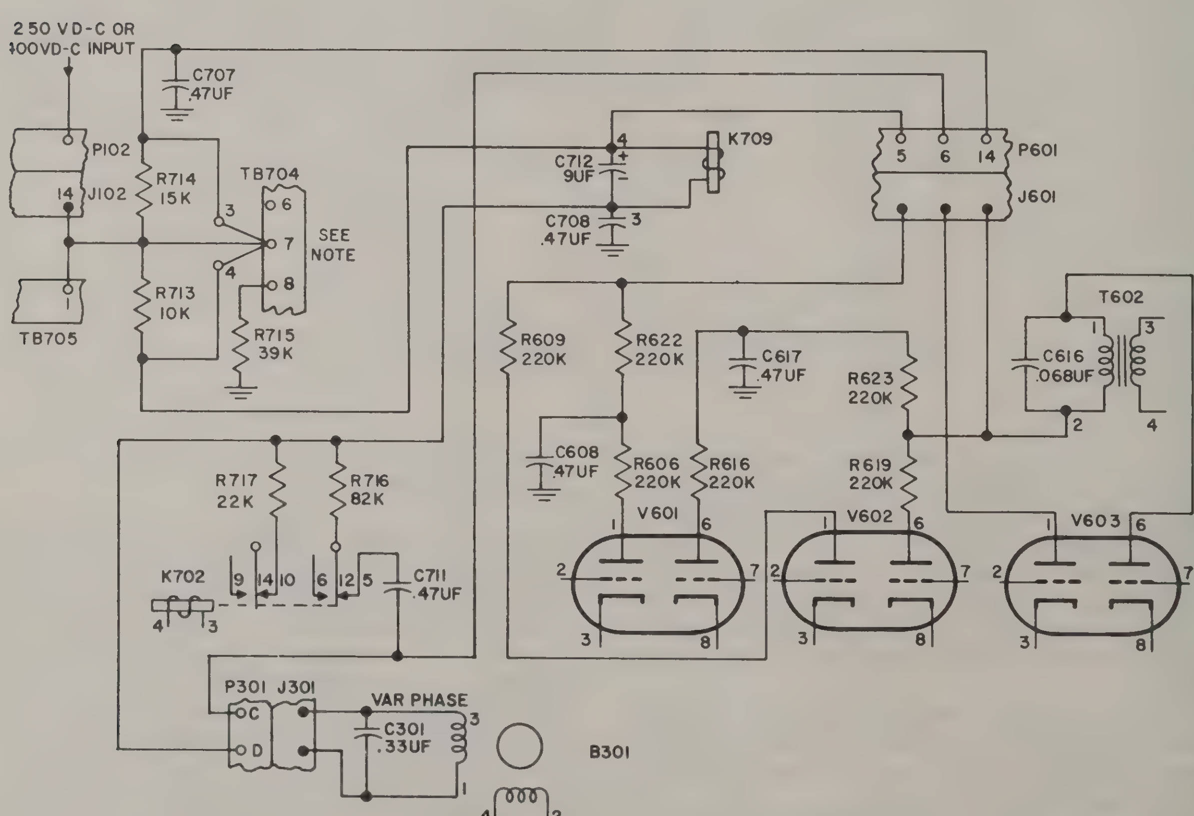


Figure 5-18. Voltage Distribution, 115-Volt, 400-CPS Line

line. The distribution should be as indicated in figure 5-19 after tuning operations are complete and all movement in the 180L-2 has ceased. When troubleshooting the 180L-2, the B-plus line may be traced through the indicated terminals and contacts. Tube socket adapters should be used to facilitate measurement of voltages on the relay and tube contacts. Connect the 180L-2 or 180L-3 in a test bench setup in accordance with steps a through i of paragraph 5.3.3.4 before performing the B-plus voltage distribution checks.

5.3.4 OVERHAUL AND REPAIR.

In order to facilitate replacement of any part contained in the variable inductor, variable capacitor, or r-f autotransformer subassemblies, disassembly procedures are outlined in the following paragraphs. Because reassembly is accomplished by reversing the disassembly procedures, no special instructions are given for reassembly. When the subassemblies are disassembled, all parts are available for cleaning, inspection, lubrication, and replacement. Cleaning procedures are listed in paragraph 5.3.4.5, and inspection procedures are listed in paragraph 5.3.4.6. For lubrication procedures, reference should be made to paragraph 5.2.1.



NOTE: TB704 IS SHOWN FOR 250-VOLT B-PLUS OPERATION. FOR 400-VOLT B-PLUS OPERATION, TB704-3 CONNECTS TO TB704-6 AND TB704-4 CONNECTS TO TB704-8.

Figure 5-19. Voltage Distribution, B-Plus Line

ITEM NO.	SYMBOL NO.	DESCRIPTION
1	E403	Coil form
2	O428	Gear
3	O432	Gear
4		Tape terminal lug
5	E401	Metal coil drum
6	O402	Gear
7	R401	Resistor
8	B401	Motor
9	J401	Jack
10	O406	Gear
11		Groove pin
12	O404	Gear assembly
13		Cable clamp
14	S402	Switch section
15	S401	Switch section
16	E409	Ceramic drum core
17	A402	Top plate
18		End plate
19		End plate
20	A404	Middle plate
21		Rear plate
22	E406, 8	R-f connectors
23	E405, 7	Contact arms
24	O434, 5	Supporting plates
25	A401	Bottom plate
26	O417	Gear
27	O419	Stop lever arm
28	O413	Gear
29	O410	Gear assembly
30	O408	Gear assembly
31	O424, 5	Springs
32	O442	Cam
33	E410	Contact
34	O442	Gear
35	E404	End plate
36	O436, 7	Springs
37	O440, 1	Pins
38	O438, 9	Pins
39	O409, 11	Bearing sleeves
40	O412	Bearing
41	O416	Bearing
42	O418	Shaft
43	O414	Post
44	O415	Washer
45	O421	Bearing
46	O422, 3	Cam spring posts
47	O426, 7	Cam stops
48	O429	Post
49	O403, 5	Gear post
50	A403	Bottom plate
51	O407	Drive shaft assembly
52	O430, 1	Bearings
53	O444	Ball bearing

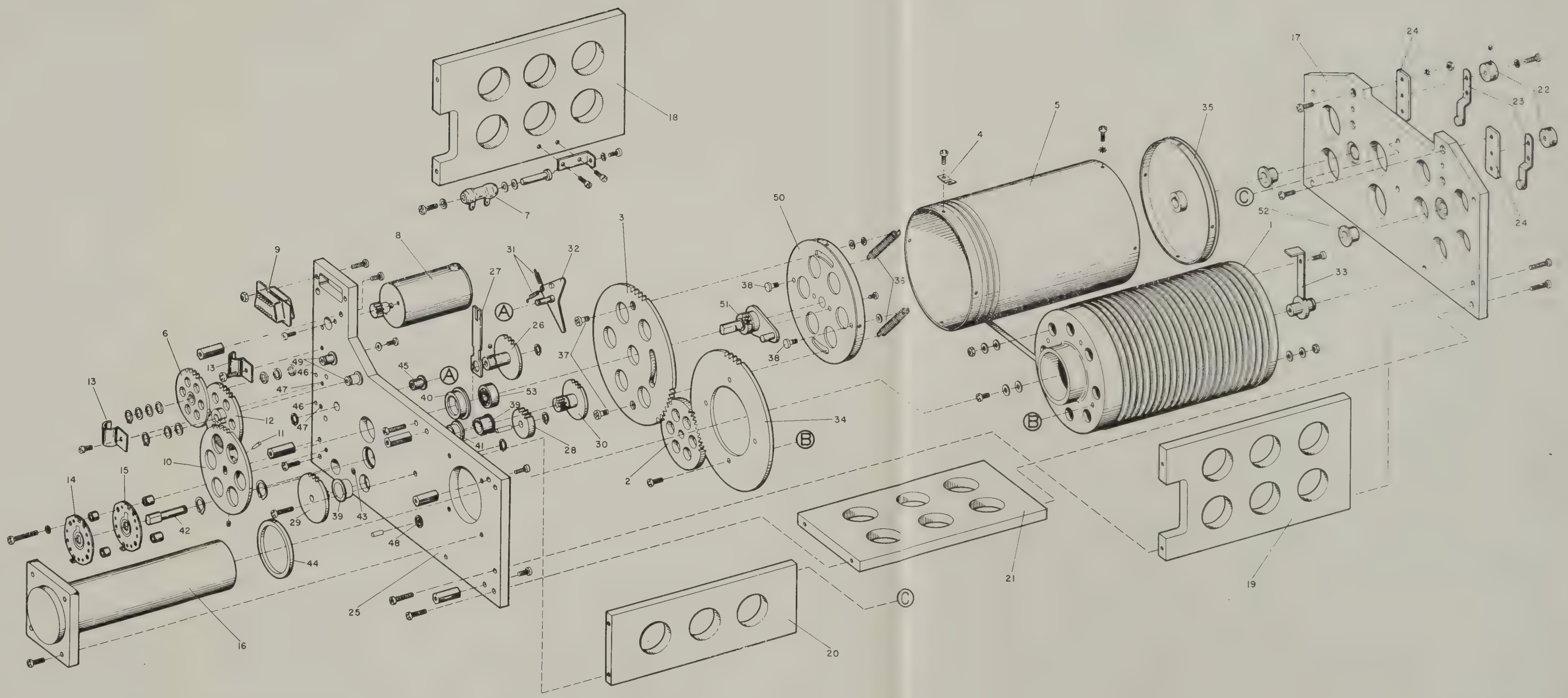


Figure 5-20. Variable Inductor Subassembly, Exploded View

Care should be exercised during the disassembly and reassembly procedures to avoid loss of small parts, washers, and gears. In addition, a wiring diagram should be drawn before removal of any part requiring unsoldering of several wires. The diagram should show any color coding or markings of the wires and the terminals to which they are connected.

NOTE

Considerable time should be spent in trouble-shooting and adjustment procedures before attempting to disassemble the 180L-2 sub-assemblies. If, however, trouble is known to exist in a detailed part or group of detailed parts which is not readily accessible, applicable portions of disassembly procedures in paragraphs 5.3.4.1 through 5.3.4.3 should be followed. These procedures are not intended to infer that a unit should be disassembled regularly since this disturbs factory adjustments.

5.3.4.1 DISASSEMBLY, VARIABLE INDUCTOR SUBASSEMBLY. Perform the following operations when it is desired to disassemble the variable inductor subassembly for maintenance procedures. Refer to figure 5-20.

a. Remove the variable inductor subassembly as outlined in paragraph 5.3.2.1.
b. Manually rotate variable inductor L401 to the maximum position. Rotate until the mechanical stop functions and the tape is on the ceramic drum (1).
c. Remove the retaining ring from gear O428 (2).
d. Hold gear O432 (3) in place and remove gear O428 (2). Carefully release the tension on gear O432 (3).
e. Remove the Phillips-head screw securing the tape terminal lug (4) to the metal drum (5).
f. Wind end of tape on ceramic drum (1), and secure with cellulose or electrical tape.
g. Remove the retaining ring from gear O402 (6), and remove gear O402.
h. Remove one Phillips-head screw and washer securing resistor R401 (7).
i. Remove two Phillips-head screws securing motor B401 (8). Remove the lacing from the B401 leads, and unsolder the leads from jack J401 (9). Unsolder the B401 lead shield.
j. Loosen the setscrew of gear O406 (10), and drive out the groove pin (item 11). Remove gear O406.
k. Remove the retaining ring from gear O404 (12), and remove gear O404.
l. Remove one Phillips-head screw securing the cable clamp (13), and remove the cable clamp.
m. Remove two Phillips-head screws securing switch S402 (14) and switch S401 (15). If the switch wafers are being replaced, unsolder the leads, and identify in some manner for later replacement.
n. Remove four Phillips-head screws securing the ceramic drum core (16), and remove the ceramic drum core.
o. Remove eight Phillips-head screws securing top plate A402 (17) to the two end plates (18 and 19), the middle plate (20), and the rear plate (21). Remove top plate A402 (17) and the ceramic and metal drums.
p. Remove six Phillips-head screws securing r-f terminals E408 and E406 (22), r-f contact arms E407 and E405 (23), and plates (24).
q. Remove seven Phillips-head screws securing the two end plates (18 and 19), the middle plate (20), and the rear plate (21) to bottom plate A401 (25). Remove the end plates, middle plate, and rear plate.
r. Remove retaining ring from gear O417 (26), and remove gear O417 and stop lever arm O419 (27).
s. Remove retaining rings from gears O413 (28), O410 (29), and O408 (30), and remove gears O413, O410, and O408 from bottom plate A401 (25).
t. Remove springs O424 and O425 (31) from posts and remove springs O424 and O425.
u. Remove retaining rings securing cam stop O420 (32) to bottom plate A401, and remove cam stop O420.
v. Unsolder the tape from the ceramic drum (1), and secure to the ceramic drum with cellulose or electrical tape.
w. Remove two screws and washers securing the contact (33) to the ceramic drum (1), and remove the terminal strip.
x. Remove four Phillips-head screws securing gear O442 (34) to the ceramic drum (1), and remove gear O442.
y. Remove seven Phillip-head screws securing the metal drum end plates (35), and remove metal drum end plates.
z. Detach springs (36), and remove retaining rings from the two pins (37). Remove gear O432 (3).

5.3.4.2 DISASSEMBLY, VARIABLE CAPACITOR SUBASSEMBLY. Perform the following operations when it is desired to disassemble the variable capacitor subassembly for maintenance procedures. Refer to figure 5-21.

a. Remove the variable capacitor subassembly as outlined in paragraph 5.3.2.2.
b. Connect the 27.5-volt d-c power source between J501-7 and J501-15 (positive 27.5 volts d-c to J501-7 and negative 27.5 volts d-c to J501-15). A Cannon type DA-15S connector may be used to complete the test connections. Leave the power switch off until completion of step c.
c. Jumper terminals 5 and 10 of J501.

CAUTION

No mechanical stops are included with the variable capacitor subassembly. If switch S501 is defective, damage may result to the variable capacitor subassembly, if run beyond the electrical stop position. To avoid this possibility, the movement of C501 should be observed carefully, and the power removed if C501 attempts to run beyond the maximum limit.

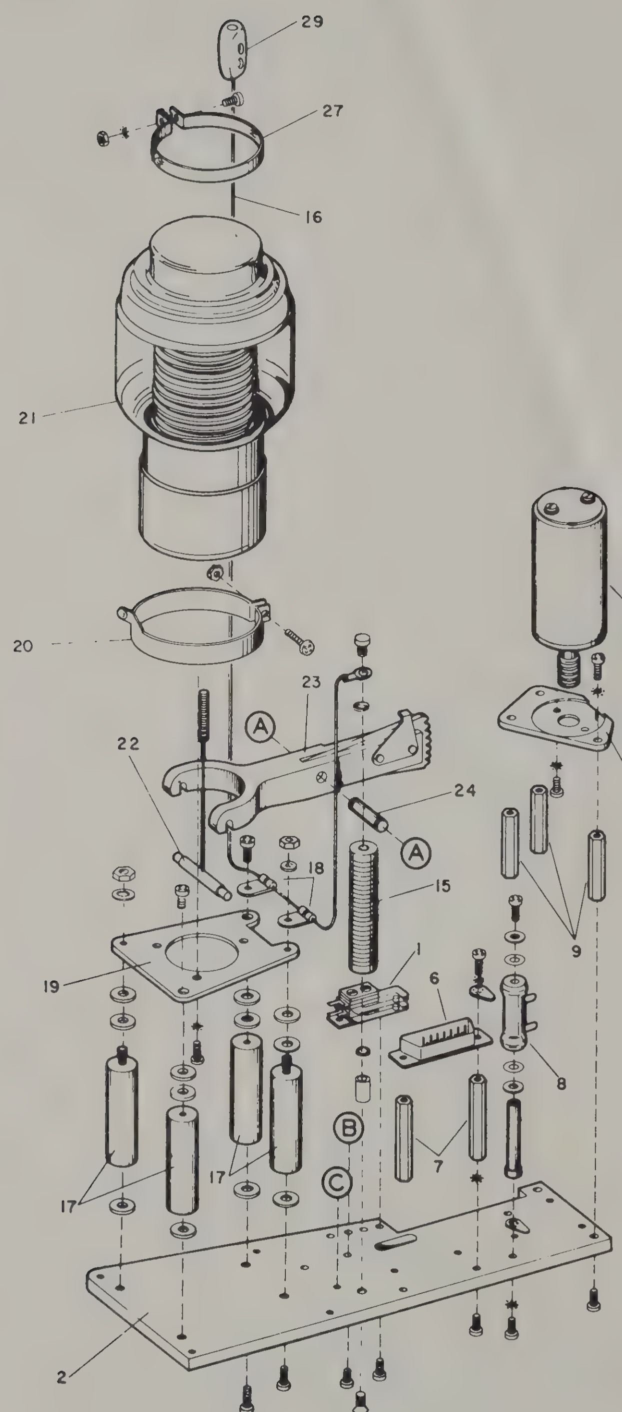


Figure 5-21. Variable Capacitor Subassembly, Exploded View

ITEM NO.	SYMBOL NO.	DESCRIPTION
1	A301	Front plate
2	S303	Switch
3	S304	Switch
4		
5	O307	Gear
6	O315, 6	Springs
7	O309	Switch actuator
8	O305	Gear assembly
9	O302	Gear assembly
10	B301	Motor
11	A302	Center plate
12	O304	Gear assembly
13	R301	Resistor
14	A303	Rear plate
15	C301	Capacitor
16	T301	Coil
17		Tension adjusting sc
18	O312	Tension spring
19	E303	Contact assembly
20	O301	Supporting shaft
21	A304	Supporting bracket
22	E301	R-f input contact
23	E306	Contact
24	H301	Standoff
25	H302	Standoff
26	J301	Connector
27	E302	R-f input connector
28	O303	Gear post
29	O306	Gear post
30	O314	Bearing
31	O313	Bearing

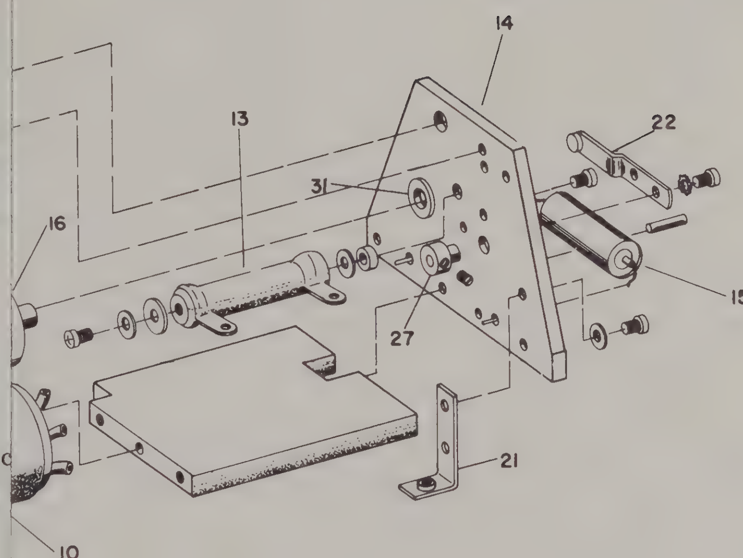
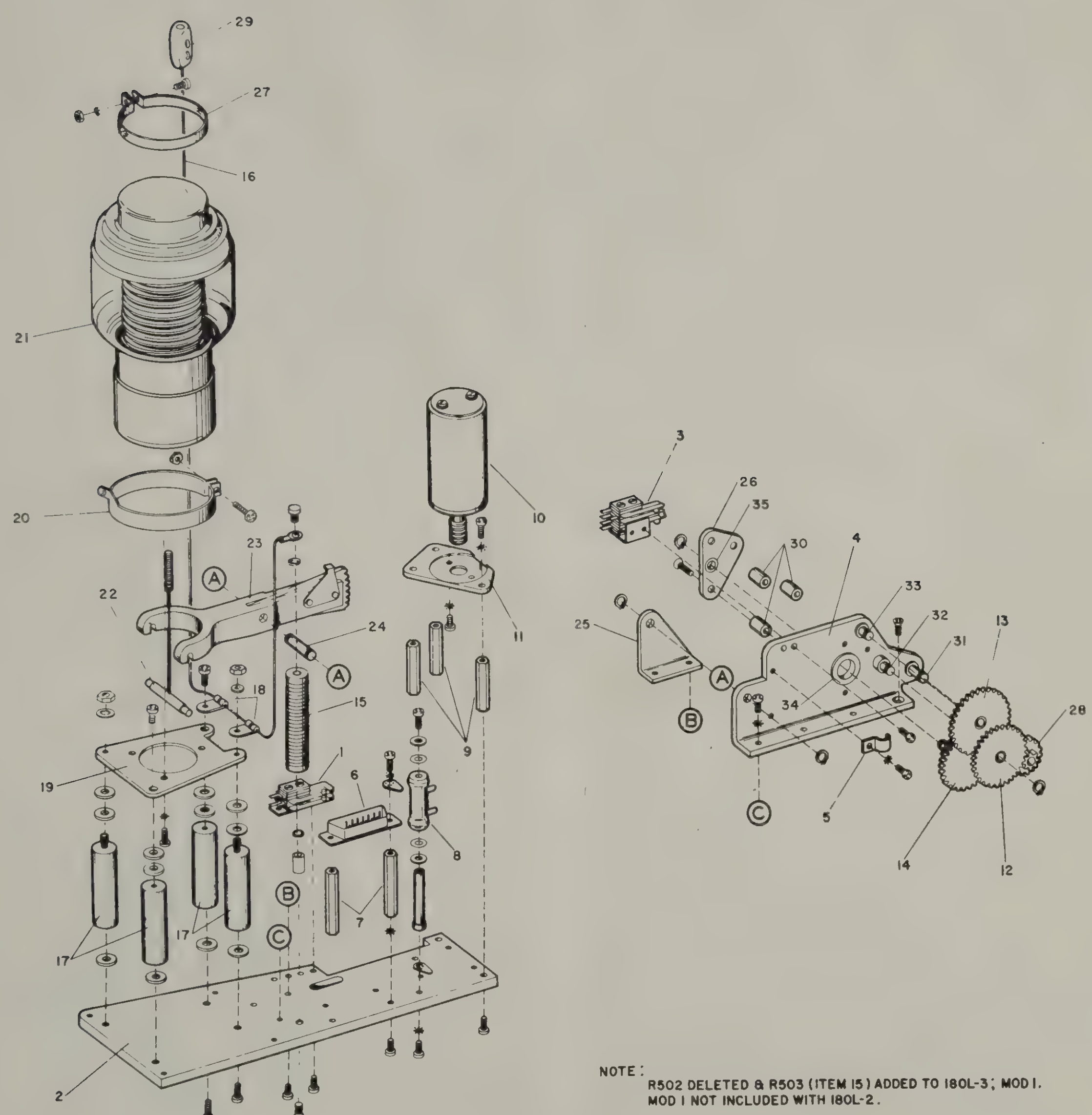


Figure 5-22. R-F Autotransformer Subassembly, Exploded View



NOTE:
R502 DELETED & R503 (ITEM 15) ADDED TO 180L-3; MOD I.
MOD I NOT INCLUDED WITH 180L-2.

Figure 5-21. Variable Capacitor Subassembly, Exploded View

ITEM NO.	SYMBOL NO.	DESCRIPTION
1	S501	Switch
2	A501	Base plate
3	S502	Switch
4	A502	Gear plate
5		Cable clamp
6	J501	Jack
7	H503	Spacing posts
8	R501	Resistor
9	H501	Spacing posts
10	B501	Motor
11	A503	Motor mounting plate
12	O504	Gear assembly
13	O506	Gear assembly
14	O508	Gear assembly
15	R503	Resistor
16		R-f lead
17	E501, 2, 3, 4	Spacer insulators
18		R-f terminals
19	A506	C501 mounting plate
20	E509	Contact
21	C501	Variable capacitor
22	O514	Yoke bar
23	O510	Yoke
24	O513	Yoke shaft
25	A505	Yoke support plate
26	A504	Bearing plate
27	E508	Terminal clamp
28	O502	Gear assembly
29	E507	Connector
30	H502	Spacers
31	O503	Gear post
32	O505	Gear post
33	O507	Gear post
34	O511	Bearing
35	O512	Bearing

ITEM NO.	SYMBOL NO.	DESCRIPTION
1	A301	Front plate
2	S303	Switch
3	S304	Switch
4		
5	O307	Gear
6	O315, 6	Springs
7	O309	Switch actuator
8	O305	Gear assembly
9	O302	Gear assembly
10	B301	Motor
11	A302	Center plate
12	O304	Gear assembly
13	R301	Resistor
14	A303	Rear plate
15	C301	Capacitor
16	T301	Coil
17		Tension adjusting screw
18	O312	Tension spring
19	E303	Contact assembly
20	O301	Supporting shaft
21	A304	Supporting bracket
22	E301	R-f input contact
23	E306	Contact
24	H301	Standoff
25	H302	Standoff
26	J301	Connector
27	E302	R-f input connector
28	O303	Gear post
29	O306	Gear post
30	O314	Bearing
31	O313	Bearing

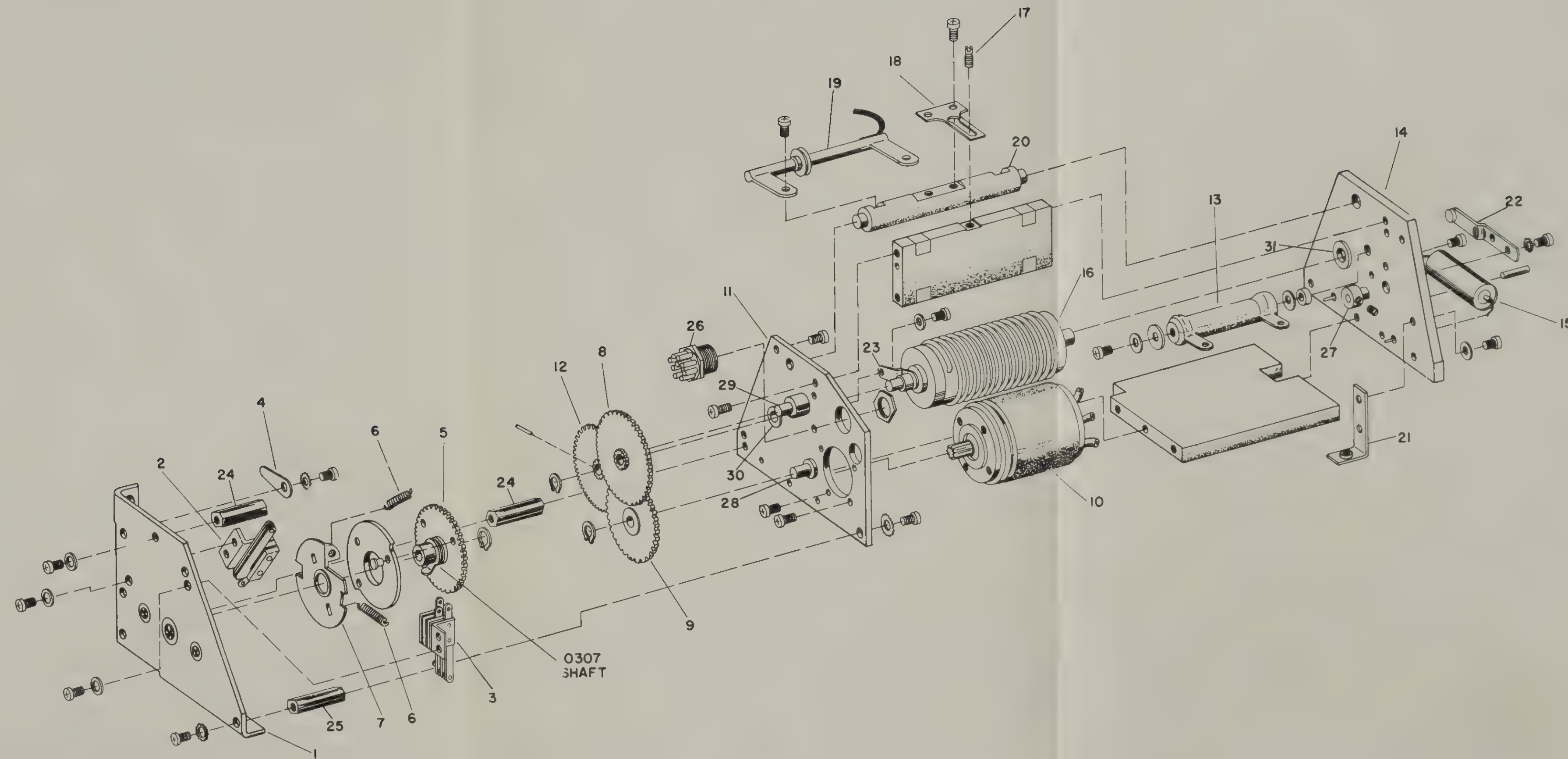


Figure 5-22. R-F Autotransformer Subassembly, Exploded View

d. Observing caution, turn the 27.5-volt d-c power switch on, and allow C501 to run to maximum. When C501 reaches maximum, the bellows should be in the extreme upward position, and contacts 3 and 4 of S501 should open and stop all movement.

e. Disconnect the 27.5-volt d-c power source from the variable capacitor subassembly.

f. Remove two Phillips-head screws securing switch S501 (1), and free switch S501 from base plate A501 (2).

g. Remove two Phillips-head screws securing switch S502 (3), and free switch S502 from gear plate A502 (4).

h. Remove one Phillips-head screw and lock washer securing the cable clamp (5), and free the cable clamp from gear plate A502 (4).

i. Remove two Phillips-head screws and lock washers securing jack J501 (6), and free jack J501 from spacing posts H503 (7).

j. Remove one Phillips-head screw and lock washer securing resistor R501 (8), and free resistor R501 from base plate A501 (2).

k. Remove the lacing from spacing post H501 (9).

l. Remove two Phillips-head screws and lock washers securing motor B501 (10) to mounting plate A503 (11).

m. Remove switches S501 and S502, jack J501, resistor R501, and motor B501 as a unit from the variable capacitor subassembly chassis.

n. Remove the retaining ring from gear O504 (12) and remove gear O504.

o. Remove the retaining ring from O506 (13) and remove gear O506.

p. Remove the retaining ring from gear O508 (14) and remove gear O508.

q. Remove one Phillips-head screw, one spacer, and one lock washer securing resistor R503 (15) to base plate A501 (2).

r. Remove one Phillips-head screw and lock washer securing resistor R503 (15) to the r-f lead (16), and remove resistor R503.

CAUTION

Avoid touching resistor R503 on the body portion. When handling R503, always hold by the ends.

s. Remove four Phillips-head screws securing spacer insulators E501, E502, E503, and E504 (17) to base plate A501 (2).

t. Remove one nut and lock washer and one Phillips-head screw securing the r-f terminals (18) to the C501 mounting plate (19), and remove the r-f terminals and r-f lead.

u. Remove one Phillips-head screw and one nut and washer securing the C501 mounting plate (19) to insulators E504 and E503 (17).

v. Tilt variable capacitor C501 (21) toward the left side (toward the end of the motor B501) to detach the yoke bar (22) from the yoke (23). Remove the contact clamp E509 (20) from the base of the vacuum capacitor (21), and remove the vacuum capacitor.

w. Remove the retaining rings from the yoke shaft (24), and remove the yoke (23).

x. Unscrew the yoke bar (22) from variable capacitor C501 (21), and remove the yoke bar.

y. Remove three Phillips-head screws and lock washers securing the C501 mounting plate (19) to variable capacitor C501 (21), and remove the C501 mounting plate.

5.3.4.3 DISASSEMBLY, R-F AUTOTRANSFORMER SUBASSEMBLY. Perform the following operations when it is desired to disassemble the r-f autotransformer subassembly for maintenance procedures. Refer to figure 5-22.

a. Remove the r-f autotransformer subassembly as outlined in paragraph 5.3.2.3.

b. Remove three Phillips-head screws and lock washers securing front plate A301 (1), and pull front plate A301 free.

c. Remove two Phillips-head screws and one washer securing switch S303 (2) to front plate A301 (1).

d. Remove two Phillips-head screws and one washer securing switch S304 (3) to front plate A301 (1).

e. Remove one Phillips-head screw and lock washer securing the solder terminal (4) to front plate A301 (1), and remove front plate A301.

f. Remove the retaining ring from gear O307 (5), and remove gear O307.

g. Remove springs O315 and O316 (6), and remove switch actuator O309 (7) from front plate A301 (1).

h. Remove the retaining ring from gear O305 (8), and remove gear O305.

i. Remove the retaining ring from gear O302 (9), and remove gear O302.

j. Remove four Phillips-head screws securing motor B301 (10) to gear plate A302 (11).

k. Remove four Phillips-head screws and lock washers from terminals 1, 2, 3, and 4 of motor B301, and remove the leads. Identify all leads removed for later replacement. Remove motor B301.

l. Drive out the groove pin of gear O304 (12) and remove gear O304.

m. Remove one Phillips-head screw and spacer securing resistor R301 (13) to rear plate A303 (14), and remove resistor R301.

n. Unsolder the leads to capacitor C301 (15). Identify leads in some manner for later replacement.

o. Remove three Phillips-head screws securing rear plate A303 (14), and remove rear plate A303.

p. Remove roller coil (16).

q. Remove the roller tension adjustment screw (17).

r. Remove the spring, contact assembly, and supporting shaft as a unit (18, 19, 20).

5.3.4.4 REASSEMBLY OF SUBASSEMBLIES. The reassembly of the variable inductor, variable capacitor, or r-f autotransformer subassembly is accomplished by reversing the disassembly procedures. During reassembly, lubricate parts as instructed in paragraph 5.2.1. In addition, when reassembling the r-f autotransformer subassembly, the shaft of gear O307 (see figure 5-22) should be lubricated with a mixture

of MIL-G-7421, 80 percent and Molykote-Z, 20 percent. Also, the alignment procedures outlined in paragraph 5.3.5 should be followed during reassembly.

NOTE

During reassembly, use liquid staking varnish on all screws where other locking methods are not used.

5.3.4.5 CLEANING. The following paragraphs contain instructions and procedures for cleaning the disassembled components of the subassemblies of Automatic Antenna Tuner 180L-2. The cleaning instructions and procedures are arranged alphabetically according to components.

All cleaning materials and protective agents that are referenced in the cleaning procedures are listed in table 5-10. Reference to the word solvent shall be understood as indicating a mixture of methylene chloride, 25 percent by volume; perchloroethylene, 5 percent by volume; and dry-cleaning solvent, Federal Spec P-S-661a, 70 percent by volume.

WARNING

Perform operations involving cleaning solvent under a ventilated hood. Avoid breathing solvent vapor; wear a suitable mask when necessary. Avoid continuous contact with solvent by use of goggles, gloves, and an apron. Change clothing that has become saturated with solvent.

When the cleaning procedure calls for the use of an air jet, a hand-operated air nozzle supplied with clean, dry, compressed air at a maximum pressure of 25 to 28 psi should be used.

WARNING

Goggles should be worn when using an air jet to blow dust and dirt from equipment parts. Other personnel should be warned away from the working area or enclosure.

Table 5-11 is a cleaning summary which lists the items to be cleaned, the various subassemblies containing these components, and paragraph numbers of the cleaning procedures.

5.3.4.5.1 BEARINGS, POROUS BRONZE. Bearings in this equipment are attached to molded plastic parts. Refer to paragraph 5.3.4.5.12.

TABLE 5-10
CLEANING MATERIALS, PROTECTIVE AGENTS

MATERIAL	SPECIFICATION
Solvent: Mixture by volume of methylene chloride 25%	ANA/AN-M-37
Perchloroethylene 5%	Federal O-T-236
Solvent, Dry-Cleaning 70%	Federal P-S-661A
Borax, powder	
Cloth, cotton; lintless	
Detergent, powder	
Grease, Lubricant	MIL-G-7421
Compound, Lubricant	Molybdenum Powder (Molykote-Z)
Oil, Lubricant	MIL-L-7870
Orangesticks	
Paper, white; fine grade	
Tool, Burnishing	
Trichloroethylene	AN-O-T-631

5.3.4.5.2 CABLE, COVERED. Clean as follows:

a. Clean the outer surface of flexible vinylite conduit by wiping with solvent-moistened, lintless cloth.
b. Wipe dry, using clean, lintless cloth.
c. Treat connector terminations as directed in paragraph 5.3.4.5.5.

5.3.4.5.3 CHASSIS, WIRED. The following procedure is used for cleaning the wired chassis containing terminal boards, resistor and capacitor assemblies, meter, rotary relay, and other wired parts.

a. Remove dust and dirt from all surfaces, including parts and winding, using soft-bristled brushes in conjunction with air jet.

CAUTION

Avoid blasting leads and small parts by too close an approach with the air-jet nozzle. Exercise due caution in use of brushes on small parts.

TABLE 5-11. CLEANING SUMMARY

ITEM	APPLICABLE SUBASSEMBLY									PARAGRAPH
	VARIABLE INDUCTOR	VARIABLE CAPACITOR	R-F AUTOTRANSFORMER	DISCRIMINATOR	SERVO AMPLIFIER	MAIN CHASSIS	FRONT PANEL	FRONT PANEL COVER	DUST COVER	
Bearings, porous bronze	X	X	X							5.3.4.5.1
Cable, covered						X				5.3.4.5.2
Chassis, wired	X	X	X	X	X	X	X			5.3.4.5.3
Coil form, ceramic	X									5.3.4.5.4
Connectors	X	X	X	X	X	X	X			5.3.4.5.5
Contacts, switch or relay	X	X	X		X	X	X			5.3.4.5.6
Covers and shields				X	X			X	X	5.3.4.5.7
Gears, metal or plastic	X	X	X							5.3.4.5.8
Insulators, ceramic or Mycalex	X	X	X	X	X	X	X			5.3.4.5.9
Machined metal parts	X	X	X	X	X	X	X			5.3.4.5.10
Mechanical metal parts	X	X	X	X	X	X	X			5.3.4.5.11
Molded plastic parts	X	X	X	X	X	X	X			5.3.4.5.12
Relays, plug-in						X	X			5.3.4.5.13
Sockets, tube, relay, or chopper					X	X	X			5.3.4.5.14
Tubes, electron					X					5.3.4.5.15

b. With minimum disturbance of wiring, clean connectors as directed in paragraph 5.3.4.5.5.

c. Disturbing wiring as little as possible, clean relay sockets as directed in paragraph 5.3.4.5.14.

d. Complete chassis cleaning by wiping down all finished surfaces with solvent-moistened, lintless cloth.

e. Dry and polish surfaces, using clean, lintless cloth.

f. Make touch-up repairs of minor damage to finish.

5.3.4.5.4 COIL FORM, CERAMIC. Perform the following:

a. Defer cleaning of the ceramic coil form until equipment is reassembled. Then, with silver ribbon transferred to the metal coil drum, wash the surface of the ceramic form with a mild solution of borax and water.

b. Dry with air jet and clean, lintless cloth.

5.3.4.5.5 CONNECTORS. Clean as follows:

NOTE

Any connectors received for overhaul which contain sealing compound will require steam-clean processes with equipment designed for the purpose, for thorough removal of the compound without damage to connectors.

a. Wipe dust and dirt from bodies, shells and cable clamps, using solvent-moistened, lintless cloth. Wipe dry with clean, lintless cloth.
b. Remove dust from inserts, using small soft-bristled brushes in conjunction with air jet.
c. Wash dirt and any traces of lubricant from insert insulation and contacts with solvent; apply sparingly with small, camel's-hair brush.

CAUTION

Do not allow solvent to run into sleeves or conduit covering any wires or cables connected to contact terminals of the insert.

d. Dry insert with air jet.

5.3.4.5.6 CONTACTS, SWITCH OR RELAY. Contacts of switches and relays should be cleaned as follows:

CAUTION

Avoid bending the contact arms of switches or relays during the cleaning operation.

a. Blow dust from surfaces with air jet.
b. Wash contact surfaces with trichloroethylene applied with camel's-hair brush.
c. Dry with air jet.
d. Remove any whitish film residue by rubbing clean white paper against contacts.

5.3.4.5.7 COVERS AND SHIELDS. Clean finished sheet-metal covers and shields according to applicable steps of procedure used for cleaning machined metal parts. Refer to paragraph 5.3.4.5.10.

5.3.4.5.8 GEARS, METAL OR PLASTIC. Clean gears and gear assemblies according to procedure for cleaning machined metal parts or molded plastic parts, as applicable. Refer to paragraphs 5.3.4.5.10 and 5.3.4.5.11.

5.3.4.5.9 INSULATORS, CERAMIC OR MYCALEX. Clean all terminal mounting insulators of glazed porcelain or Mycalex as follows:

a. Wipe clean with solvent-moistened, lintless cloth.
b. Dry and polish, using clean, lintless cloth.

5.3.4.5.10 MACHINED METAL PARTS. Detached metal gears and similar machined parts should be cleaned in a suitable machine, if available. Otherwise proceed as follows:

a. Remove bulk of surface grease or oil with rag.
b. Blow dust from surfaces, holes, and recesses with air jet.
c. Immerse in washing bath of solvent and scrub until clean. Flat, wood-backed, nonmetallic brushes are recommended for surfaces; round brushes similar to those for washing bottles and test tubes are recommended for holes and recesses.
d. Raise from bath and let solvent drain into bath.
e. Immerse in rinsing bath of clean solvent, rinse and raise from bath. Position to drain dry so that solvent is not trapped in holes or recesses, or use air jet to remove trapped solvent. Dry in dust-free, dry area or in ventilated enclosure equipped with radiant heat.
f. When thoroughly dry, apply a light coat of MIL-L-7870 lubricating oil to any bare steel surfaces.

5.3.4.5.11 MECHANICAL METAL PARTS. Detached miscellaneous metal parts, including mounting plates, clamps, brackets, nuts, bolts, screws, and washers, should be cleaned in a suitable machine or according to applicable steps of the procedure for machined metal parts described in paragraph 5.3.4.5.10.

5.3.4.5.12 MOLDED PLASTIC PARTS. Plastic parts including end plates, insulating members, and terminal boards are cleaned in the following manner:

a. With air jet, blow loose dirt and dust from surfaces, holes, and recesses including such attached metal parts as bearings and contacts.
b. Wipe clean, using solvent-moistened, lintless cloth.
c. Dry and polish, using clean, lintless cloth.

5.3.4.5.13 RELAYS, PLUG-IN. Clean as follows:

a. Remove dust and dirt from surfaces of metal cases, using solvent-moistened, lintless cloth.
b. Dry and polish with clean, lintless cloth.
c. Clean bottom of bases and contact pins with soft-bristled brush. See caution notice in paragraph 5.3.4.5.14.

5.3.4.5.14 SOCKETS, TUBE, RELAY, OR CHOPPER. Mica-filled, Bakelite sockets are cleaned as follows:

CAUTION

Do not use metal tools to remove foreign matter from contacts. Damage to plating will invite corrosion already present. Replace the socket involved.

a. Remove any rosin adhering to plated contacts, using orangesticks dressed to wedge ends.
b. Wash contacts with solvent, applied lightly with small, soft-bristled brush.
c. Using solvent-moistened, lintless cloth, remove any foreign matter adhering to socket body or wafer.
d. Dry all parts with air jet.

5.3.4.5.15 TUBES, ELECTRON. Clean as follows:

a. Remove dust and dirt from surface of glass envelope with solvent-moistened, lintless cloth. Apply lightly to avoid obliterating tube markings.
b. Dry and polish surface by wiping gently with clean, lintless cloth.
c. Clean bottom of base and all tube contact pins with soft-bristled brush. Straighten contacts as necessary with a tube-pin straightener.

CAUTION

Do not use abrasives or metal tools to remove corrosion on tube contacts. The deposits are indication of damage to plating and inspection will probably order tube replacement.

5.3.4.6 INSPECTION. The following paragraphs contain procedures designed to determine, by inspection, the condition of the disassembled and cleaned components of the subassemblies of Automatic Antenna Tuner 180L-2. Defects resulting from wear, physical damage, deterioration, or other similar causes are brought to light by these inspection procedures. The inspection procedures are arranged alphabetically according to components, first mechanical then electrical. Table 5-12 is an inspection summary which lists the items to be inspected, the various subassemblies containing these components, and paragraph numbers of the inspection procedures.

5.3.4.6.1 BEARINGS. Inspect bearings for tarnished external surfaces, pitted or scuffed surfaces, flaking, or other abnormal conditions.

5.3.4.6.2 COVERS AND SHIELDS. Inspect covers and shields for deformation, punctures, deep dents, and badly worn surfaces. Check for damaged fasteners and handles. Examine for corrosion and similar damage to finish.

5.3.4.6.3 GEAR, METAL OR PLASTIC. Table 5-13 lists all gears used in this equipment and the basic specifications of each. The wear of gear teeth or bore, except in instances where it is sufficiently severe to be apparent by visual inspection, is best determined by gauge measurements which can be compared to the measurements in table 5-13.

TABLE 5-12. INSPECTION SUMMARY

ITEM	APPLICABLE SUBASSEMBLY									PARAGRAPH
	VARIABLE INDUCTOR	VARIABLE CAPACITOR	R-F AUTOTRANSFORMER	DISCRIMINATOR	SERVO AMPLIFIER	MAIN CHASSIS	FRONT PANEL	FRONT PANEL COVER	DUST COVER	
MECHANICAL PARTS										
Bearings, porous bronze	X	X	X							5.3.4.6.1
Covers and shields				X	X			X	X	5.3.4.6.2
Gears, metal or plastic	X	X	X							5.3.4.6.3
Machined metal parts	X	X	X	X	X	X	X			5.3.4.6.4
Mechanical metal parts	X	X	X	X	X	X	X			5.3.4.6.5

TABLE 5-12. INSPECTION SUMMARY (Cont)

ITEM	APPLICABLE SUBASSEMBLY									PARAGRAPH
	VARIABLE INDUCTOR	VARIABLE CAPACITOR	R-F AUTOTRANSFORMER	DISCRIMINATOR	SERVO AMPLIFIER	MAIN CHASSIS	FRONT PANEL	FRONT PANEL COVER	DUST COVER	
ELECTRICAL AND ELECTRONIC PARTS										
Cable, covered						X				5.3.4.6.6
Capacitors, fixed			X	X	X	X	X			5.3.4.6.7
Coils, r-f				X	X	X	X			5.3.4.6.8
Connectors	X	X	X	X	X	X	X			5.3.4.6.9
Contacts, relay or switch	X	X	X		X	X	X			5.3.4.6.10
Insulators, ceramic or Mycalex	X	X	X	X	X	X	X			5.3.4.6.11
Molded plastic parts	X	X	X	X	X	X	X			5.3.4.6.12
Relays, plug-in						X	X			5.3.4.6.13
Resistors, fixed composition		X		X	X	X	X			5.3.4.6.14
Resistors, fixed wire-wound	X	X	X			X				5.3.4.6.15
Sockets; tube, chopper, or relay					X	X	X			5.3.4.6.16
Soldered terminal connections	X	X	X	X	X	X	X			5.3.4.6.17
Transformers			X	X	X					5.3.4.6.18
Tubes, electron					X					5.3.4.6.19
Wiring	X	X	X	X	X	X	X			5.3.4.6.20

NOTE

The presence of a sharp burr on the edges of the teeth is an indication of wear.

In addition to the measurements listed in table 5-13, all gears should be inspected as follows:

a. Inspect for broken, chipped, or badly worn teeth.
b. Inspect gear bodies for cracks or deformation.
c. Inspect bore for excessive wear.
d. Inspect surfaces for corrosion or other abnormal condition.
e. Inspect for proper lubrication.

5.3.4.6.4 MACHINED METAL PARTS. Inspect as follows:

a. Make over-all check for physical damage to surfaces, corners, and edges.

b. Inspect closely all machined plane surface, holes, bores, grooves, shoulders, flanges, teeth, tapped holes, and threaded members for physical damage including roughness of surface, corrosion, and presence of foreign matter.

c. Inspect plated or finished areas for damage requiring refinishing beyond touch-up repair.

5.3.4.6.5 MECHANICAL METAL PARTS. Inspect unmachined metal parts including mounting plates, chassis, clamps and brackets, nuts, bolts, screws, washers, handles, fasteners, and hardware for physical damage and deformation. Check the parts for corrosion and any damage requiring refinishing beyond touch-up repair.

5.3.4.6.6 CABLE, COVERED. Inspect flexible vinylite conduit as follows:

a. Inspect for physical damage throughout entire length.

b. Inspect at ends to make certain conduit is not pulled loose from connectors.

c. Inspect all connectors as outlined in paragraph 5.3.4.6.9.

5.3.4.6.7 CAPACITORS, FIXED. Inspect capacitors for defects listed in table 5-14.

TABLE 5-13. GEAR SPECIFICATIONS

GEAR	TYPE	NO. OF TEETH	DIA PITCH	THEORETICAL PITCH DIAMETER (inches)	BORE (inches)	FACE WIDTH (inches)	MATERIAL
R-F AUTOTRANSFORMER SUBASSEMBLY							
B301	Pinion	15	96	0.1572	0.1765	0.4375	Stainless steel
O302	Follower	144	96	0.5000	0.4375	0.0600	Brass
	Driver	33	48	0.6875	0.1880	0.1250	Phosphor bronze
O304	Follower	72	48	1.5000	0.2187	0.0620	Brass
	Driver	17	64	0.2656	0.1560	0.2100	Phosphor bronze
O305	Follower	107	64	1.6718	0.2812	0.0620	Brass
	Driver	21	64	0.3281	0.1875	0.1180	Phosphor bronze
O307	Follower	103	64	1.6093	0.2812	0.0600	Phosphor bronze
VARIABLE INDUCTOR SUBASSEMBLY							
B401	Pinion	20	64	0.3125	0.1250	0.1875	Stainless steel
O402	Follower	96	64	1.5000	0.5000	0.0600	Phosphor bronze
	Driver	32	48	0.6670	0.3750	0.1350	Stainless steel
O404	Follower	80	48	1.6670	0.3750	0.0600	Brass
	Driver	24	48	0.5000	0.3120	0.2500	Stainless steel
O406	Follower	100	48	2.0830	0.2510/0.1875	0.0930	Phosphor bronze
O407	Driver	24	48	0.5000	0.2500	0.0940	Stainless steel
O408	Follower	48	48	1.000	0.1875	0.0620	Brass
	Driver	15	48	0.3130	0.1562	0.1875	Stainless steel
O410	Follower	60	48	1.2500	0.1875	0.0920	Brass
	Driver	15	48	0.3130	0.1562	0.1875	Stainless steel

TABLE 5-13. GEAR SPECIFICATIONS (Cont)

GEAR	TYPE	NO. OF TEETH	DIA PITCH	THEORETICAL PITCH DIAMETER (inches)	BORE (inches)	FACE WIDTH (inches)	MATERIAL
VARIABLE INDUCTOR SUBASSEMBLY (Cont)							
0413	Idler	36	48	0.7500	0.1875	0.1560	Aluminum
0417	Cam Drive	49	48	1.0210	0.2500	0.0620	Brass
0428	Idler	56	32	1.7500	0.2500	0.1560	Plastic
0432	Drum Loading	120	32	3.7500	0.5625	0.0930	Plastic
0442	Drum	120	32	3.7500	2.000	0.0930	Plastic
VARIABLE CAPACITOR SUBASSEMBLY							
B501	Worm	Single right-hand	64	0.3124	1.2500	0.4375	Stainless steel
0502	Helical Driver	50 18	64 48	0.7822 0.3750	0.3125 0.1875	0.1875 0.1875	Phosphor bronze Phosphor bronze
0504	Follower Driver	60 22	48 48	1.2500 0.4580	0.3125 0.1875	0.0600 0.1370	Brass Phosphor bronze
0506	Follower Driver	64 20	48 48	1.2500 0.4170	0.3125 0.1880	0.0760 0.1400	Brass Phosphor bronze
0508	Follower Driver	54 18	48 48	1.1250 0.3750	0.3125 0.1875	0.0900 0.3120	Brass Stainless steel

TABLE 5-14. INSPECTION OF FIXED CAPACITORS

DEFECT	METAL CASE	MOLDED TYPE	CERAMIC TYPE
Body damage (cracks, breakage)			X
Case damage (dents, holes)	X		
Case damage (cracks, breakage)		X	
Insulation damage (cracked, broken charred)	X		X

DEFECT	METAL CASE	MOLDED TYPE	CERAMIC TYPE
Terminal damage (loose, broken, corroded)	X	X	X
Terminal damage (loose, broken, poorly soldered connections)	X	X	X
Mounting damage (loose, broken)	X	X	X

5.3.4.6.8 COILS, R-F. Inspect r-f coils and lines for broken leads; loose, poorly soldered, or broken terminal connections; and loose mountings. Also check for crushed, scratched, or cut windings; corrosion on windings, leads, terminals, contacts and connections; and for physical damage to forms.

5.3.4.6.9 CONNECTORS. Inspect as follows:

a. Inspect connector bodies for broken parts, deformed shell or clamp, and other abnormal conditions, depending on type.
b. Inspect connector for cracked and broken insulation and for contacts which are broken, deformed, or out of alignment. Also check for corrosion or damage to plating and for loose, poorly soldered, broken, or corroded terminal connections.

5.3.4.6.10 CONTACTS, RELAYS AND SWITCHES. Inspect contacts of rotary relay and switches for burned or pitted areas, corrosion, welds, misalignment, and improper separation.

a. Check support members for deformation causing contact misalignment or improper operation.
b. With fingers, test movable contacts for sluggish operation or sticking at any point of travel in either direction.
c. Inspect for loose coil, corrosion, loose leads or terminals, and for cuts and damage to coil.
d. Inspect for loose, broken, brittle or charred insulation on coil or leads, between contact support members, and between terminals.
e. Check mountings and mechanical parts for looseness and physical damage or corrosion.

5.3.4.6.11 INSULATORS, CERAMIC OR MYCALEX. Inspect insulators for cracks, chipping, or breakage. Check for signs of burning, looseness, or other abnormal conditions.

5.3.4.6.12 MOLDED PLASTIC PARTS. Inspect parts, such as terminal boards and insulating members, for signs of corrosion, cracked, broken, or charred insulation and for loose or missing hardware.

5.3.4.6.13 RELAYS, PLUG-IN.

a. Inspect metal case for dents and obliterated markings.
b. Check base for cracked, chipped, or broken body or key.
c. Inspect for loose, deformed, broken, or misaligned contacts. Check for corrosion or other damage to contact plating.

5.3.4.6.14 RESISTOR, FIXED COMPOSITION. Inspect for cracked, broken, blistered, or charred bodies and for loose, broken, poorly soldered, or corroded terminal connections.

5.3.4.6.15 RESISTORS, FIXED WIRE-WOUND. Inspect for signs of undue heating; cracked, broken or charred insulation; and loose, poorly soldered, or corroded terminal connections.

5.3.4.6.16 SOCKETS, TUBE, RELAY OR CHOPPER. Mica-filled, Bakelite sockets are inspected as follows:

a. Inspect for loose, broken, missing, or improperly seated mounting rings. Check for cracked, broken, or charred insulation.
b. Inspect for broken, deformed, or corroded contacts and for loose, poorly soldered, or corroded terminal connections.

5.3.4.6.17 SOLDERED TERMINAL CONNECTIONS. Inspect as follows:

a. Inspect for cold-soldered or "rosin" joints. These joints present a porous or dull, rough appearance. Check strength of bond with point of a tool.
b. Examine for excess solder, protrusions from joints, pieces adhering to adjacent insulators, and particles lodged between joints or conductors.
c. Inspect for insufficient solder and unsoldered strands of wire protruding from conductor at joint. Check for insulation stripped back too far from joint or frayed at joint.
d. Inspect for corrosion on copper conductor at joint.

5.3.4.6.18 TRANSFORMERS. Inspect for signs of excessive heating, physical damage to case, cracked or broken insulation, and other abnormal conditions. Check for corroded, poorly soldered, or loose terminals and loose, broken, or missing mounting hardware.

5.3.4.6.19 TUBES, ELECTRON.

a. Inspect envelope for cracked glass and obliterated markings.
b. Inspect for deformed, broken, or misaligned tube contacts. Check for corrosion or other damage to contact plating.

5.3.4.6.20 WIRING. Inspect open and laced wiring of chassis, terminal boards, and other parts of equipment. Check insulation for physical damage and charring. Check wires for breakage and improper dress in relation to adjacent wiring or chassis.

5.3.5 ALIGNMENT.

The following paragraphs contain procedures for precision alignment of the variable inductor, variable capacitor, r-f autotransformer, and servo-amplifier subassemblies of Automatic Antenna Tuner 180L-2.

When the alignment and tracking procedures have been completed, the 180L-2 should be subjected to the preinstallation bench test in paragraph 2.3 and the operational check in paragraph 5.2.2. For removal and replacement of subassemblies, refer to paragraph 5.3.2.

NOTE

The alignment procedures should be performed only when it has been proved that a mulfunction is caused through misalignment or when subassemblies have been disassembled and reassembled for overhaul and repair purposes.

5.3.5.1 VARIABLE INDUCTOR SUBASSEMBLY. The alignment procedures for the variable inductor subassembly include end-stop alignment, gear meshing, and alignment of switches S401A, S401B, S402A, and S402B. These procedures are outlined in paragraphs 5.3.5.1.1 through 5.3.5.1.3.

5.3.5.1.1 END-STOP ALIGNMENT. Remove the subassembly, and perform the following operations: (Refer to figures 5-23 through 5-25.)

a. Rotate variable inductor L401 to maximum (all of the tape on the ceramic drum). The mechanical end stop should operate when approximately one turn is left on the metal drum.

b. Remove the retaining ring of gear O428.

c. Hold metal drum gear O432 and remove gear O428. Carefully release the tension on gear O432.

d. Remove the Phillips-head screw securing the tape terminal lug, and wind all of the tape onto the ceramic drum. Secure tape to ceramic drum with cellulose or electrical tape.

e. Loosen the setscrew of gear O406 and drive out the groove pin. Remove gear O406.

f. Remove eight Phillips-head screws securing top plate A402, and remove top plate A402. Carefully remove the ceramic drum.

g. With the variable inductor subassembly in a normal upright position, lift the metal drum to unmesh the gearing and rotate gear O410 until the stop lever arm starts to move.

h. With the metal drum gearing unmeshed, rotate the metal drum until the stop pin is nearest the middle plate. The stop pin protrudes from the bottom of gear O432 and may be observed from the front of the variable inductor subassembly, between gear O432 and bottom plate A401.

i. With the stop pin oriented as stated in step h, remesh the metal drum gearing.

j. Viewing the variable inductor subassembly from the front (side of motor B401) and top, rotate the metal drum clockwise until the stop pin engages the cam stop near the tip. Continue to rotate the metal drum, and observe the cam stop and stop lever arm. The stop pin should pull the cam stop away from the stop lever arm to release the load on the gearing.

k. Rotate the metal drum 24 turns counterclockwise and observe for correct indication as stated in step j. If necessary, lift the metal drum to unmesh the gearing, and rotate a few degrees to obtain correct operation.

l. When operation is correct in step k, rotate the metal drum to the maximum clockwise position. Replace the tape terminal lug, ceramic drum, top plate A402, and gear O406.

m. Position the ceramic and metal drums so that half of the tape is on each drum.

n. Make matching index marks on gear O432 and the metal drum. Hold the metal drum, and rotate gear O432 to the limit of travel against the spring tension. Make a second index mark on the metal drum opposite the mark on gear O432.

o. Set gear O432 so that its index marks falls halfway between the two index marks on the metal drum. Hold gear O432 and the metal drum in this position.

p. Replace gear O428, meshing with gears O432 and O442. Replace the retaining ring on gear O428.

q. Test the end-stop positioning by rotating L401 to both the maximum and minimum positions. At maximum, approximately one turn should remain on the metal drum. At minimum, approximately 1/8 turn should remain on the ceramic drum.

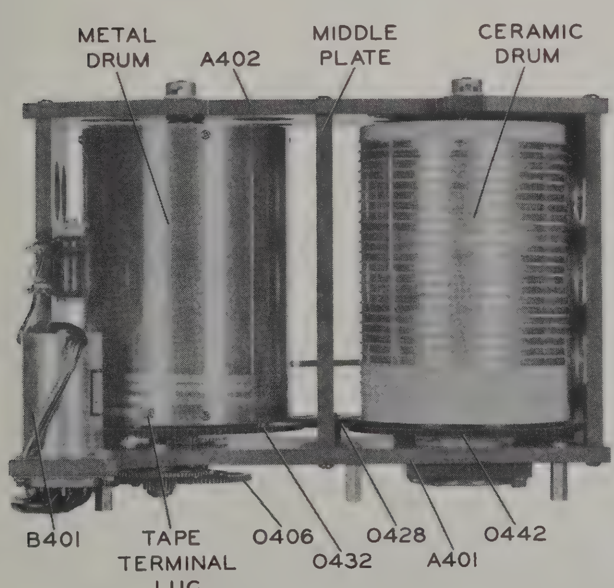


Figure 5-23. Variable Inductor Subassembly, Front View, Alignment Points

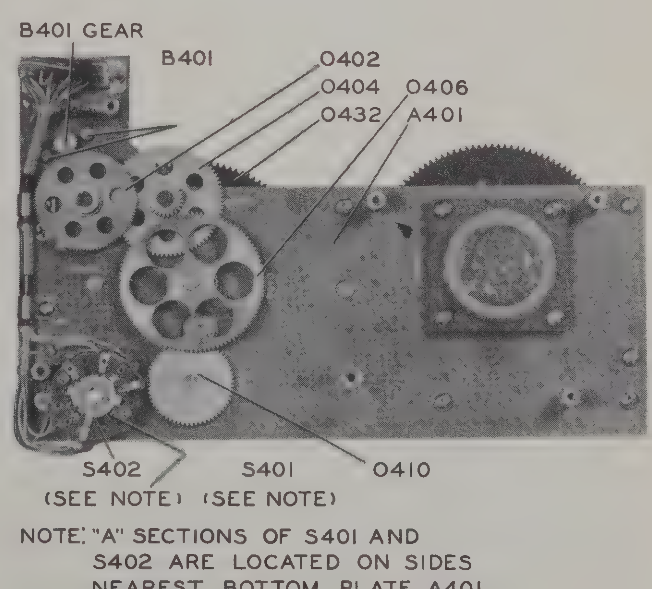


Figure 5-24. Variable Inductor Subassembly, Bottom View, Alignment Points

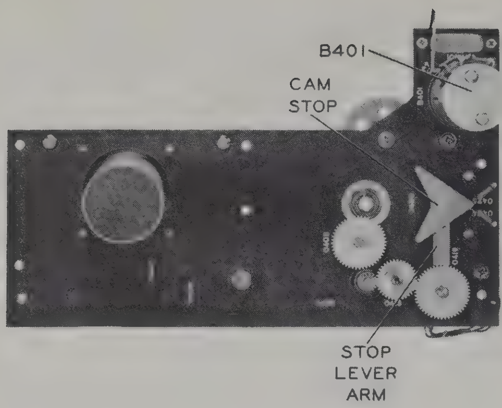


Figure 5-25. Variable Inductor Subassembly, Top View with Drums Removed, Alignment Points

5.3.5.1.2 GEAR MESHING. If the mesh of gear O402 with the B401 gear appears loose or if the backlash appears excessive, remove the subassembly, and perform the following operations: (Refer to figure 5-24.)

a. Loosen the two Phillips-head screws securing motor B401 to bottom plate A401.
b. Move motor B401 until gear O402 is meshed with the B401 gear for free-running with minimum backlash.
c. Tighten the two Phillips-head screws with B401 in the position determined in step b.

5.3.5.1.3 SWITCH ALIGNMENT. To align switches S401A, S401B, S402A, and S402B, remove the subassembly, and perform the following operations: (Refer to figures 5-26 and 5-27.)

a. Rotate variable inductor L401 to the mechanical limit in the maximum position.

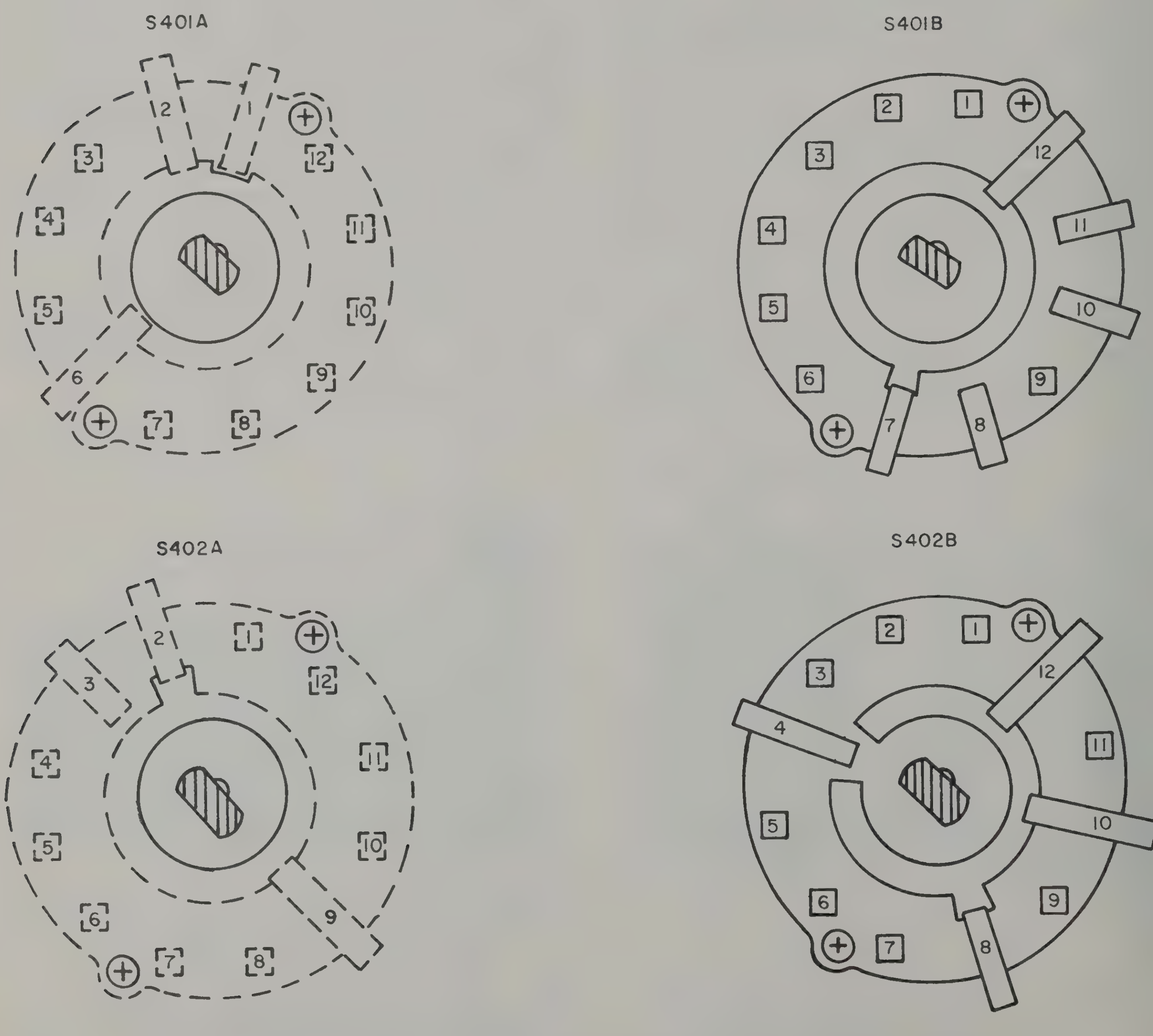


Figure 5-26. Variable Inductor Subassembly, Maximum Position, Switch Alignment

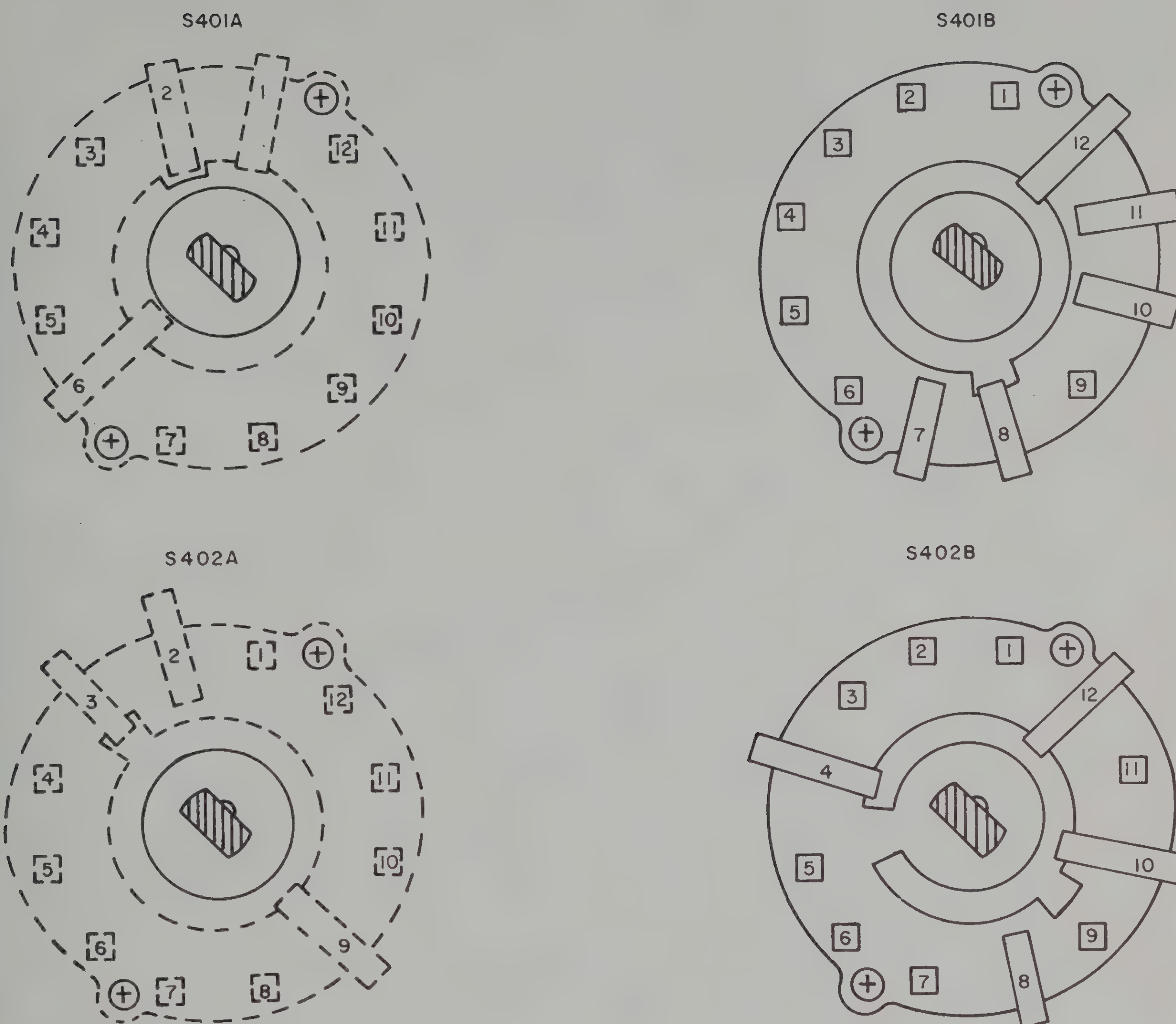


Figure 5-27. Variable Inductor Subassembly, Minimum Position, Switch Alignment

b. Observe the positions of switches S401A, S401B, S402A, and S402B. Compare with figure 5-26. To observe switches S401A, S401B, and S402A, it is necessary to remove the two Phillips-head screws securing the switch wafers to bottom plate A401.

c. If the switches are out of alignment, loosen the setscrews securing the switch shaft (located between S401 and bottom plate A401), and rotate the switch shaft for correct alignment.

d. Tighten the setscrews, and replace the two Phillips-head screws in the switch wafers. Rotate L401 to the mechanical limit at the minimum position.

e. Observe the positions of switches S401A, S401B, S402A, and S402B. Compare with figure 5-27. Remove the two Phillips-head screws securing the switch wafers if necessary. If the switches are out of alignment at the minimum position and correctly aligned at the maximum position, repeat the end-stop alignment outlined in paragraph 5.3.5.1.1.

f. Rotate L401 to both the maximum and minimum positions, and observe for indications as listed in steps g and h.

g. With L401 going toward maximum, the switches should operate in the following time sequence: The tab of S402A-2 makes contact with the S402A wiper; the tab of S402B-8 makes contact with the S402B wiper; the S402B open rotor segment opens the circuit to S402B-4; the S401A open rotor segment opens the circuit to S401A-1.

h. With L401 going toward minimum, the switches should operate in the following time sequence: The tab of S402A-3 makes contact with the S402A wiper;

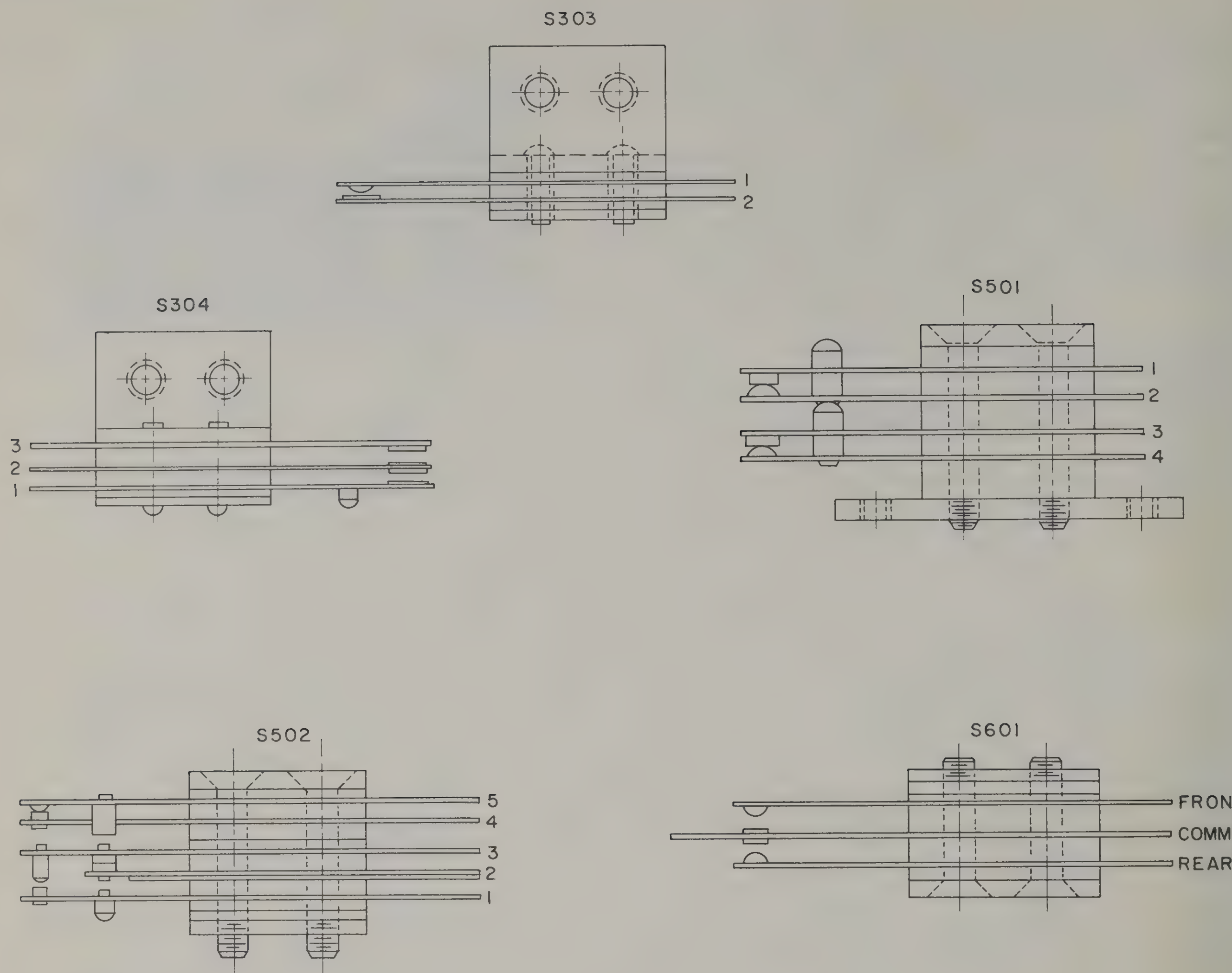


Figure 5-28. Switches S303, S304, S501, S502, and S601, Contact Location

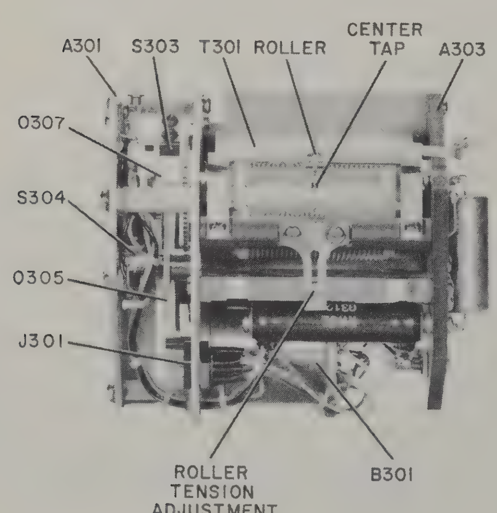


Figure 5-29. R-F Autotransformer Subassembly, Alignment Points

the tab of S401B-8 makes contact with the S401B wiper.

5.3.5.2 VARIABLE CAPACITOR SUBASSEMBLY. The alignment procedures for the variable capacitor subassembly include switch alignment and gear meshing. These procedures are outlined in paragraphs 5.3.5.2.1 and 5.3.5.2.2 which follow.

5.3.5.2.1 SWITCH ALIGNMENT. To align switches S501 and S502, remove the subassembly, and perform the following operations: (Refer to figures 5-3 and 5-28.)

a. Connect the 27.5-volt d-c power source between J501-7 and J501-15 (positive 27.5 volts d-c to J501-7 and negative 27.5 volts d-c to J501-15). A Cannon type DA-15S connector may be used to complete the test connections. Leave the power switch off until completion of step b.

b. Jumper terminals 5 and 10 of J501.

CAUTION

No mechanical stops are included with the variable capacitor subassembly. If switches S501 or S502 are defective, damage may result to the variable capacitor subassembly if run beyond the electrical stop position. To avoid this possibility, the movement of C501 should be observed carefully and the power removed if C501 attempts to run beyond the maximum or minimum limit.

c. Observing caution, turn on the 27.5-volt d-c power switch, and observe the movement of C501 to maximum. Compare the results with steps d and e.
d. When C501 reaches maximum, contacts 1 and 2 of S501 should open and then contacts 3 and 4 of S501 should open.
e. When contacts 3 and 4 of S501 open, all movement should cease.
f. If necessary, adjust the stationary S501 contact arms or the maximum limit tab to obtain correct operation as outlined in steps d and e.
g. Remove the DA-15S connector used in steps a through f. Replace with a second DA-15S connector and complete the test connections as outlined in steps d and c.
h. Connect the 27.5-volt d-c power source between J501-5 and J501-15 (plus 27.5 volts d-c to J501-5 and negative 27.5 volts d-c to J501-15). Leave the power switch off until completion of step i.
i. Jumper terminals 7 and 2 of J501.
j. Observing caution, turn on the 27.5-volt d-c power switch, and observe the movement of C501 to minimum. Compare the results with steps k and l.
k. When C501 reaches minimum, contacts 1 and 3 of S502 should close and then contacts 4 and 5 of S502 should open.
l. When contacts 4 and 5 of S502 open, all movement should cease.
m. If necessary, adjust the stationary S502 contact arms to obtain correct operation as outlined in steps k and l.

5.3.5.2.2 GEAR MESHING. If the mesh of gear O502 with the B501 worm gear appears loose or if the backlash appears excessive, remove the subassembly, and perform the following operations: (Refer to figure 5-3.)

a. Loosen the two Phillips-head screws securing motor B501 to the mounting plate. The B501 mounting screws are located beneath the B501 mounting plate.
b. Move motor B501 until gear O502 is meshed with the B501 worm gear for free-running with minimum backlash.
c. Tighten the two Phillips-head screws with B501 in the position determined in step b.

5.3.5.3 R-F AUTOTRANSFORMER SUBASSEMBLY. The alignment procedures for the r-f autotransformer subassembly include mechanical alignment, gear meshing, and alignment of switches S303 and S304. These procedures are outlined in paragraphs 5.3.5.3.1 through 5.3.5.3.3 which follow.

5.3.5.3.1 MECHANICAL ALIGNMENT. Remove the subassembly, and perform the following operations: (Refer to figure 5-29.)

a. Measure the tension required to lift the roller of T301 from the coil. A hand scale may be used. The tension should be between 8 and 10 ounces. If necessary, adjust the tension by rotating the roller tension adjustment screw.

CAUTION

When rotating r-f autotransformer T301 manually, it is possible to damage the gearing by forcing the coil past the stop positions. To avoid damage, care should be taken during the mechanical alignment procedures.

b. Rotate the coil of T301 to the maximum stop position (roller toward rear plate A303). If the roller is not on the last turn, lift the roller and place on the last turn. The roller should be between 1/6 and 5/6 turn from the end of the coil.
c. If the roller is not between 1/6 and 5/6 turn from the end, remove three Phillips-head screws and lock washers securing front plate A301 and remove A301. Rotate gear O307 with respect to gear O305 and remesh gears O307 and O305. Replace front plate A301 and repeat the positioning test outlined in step b. If necessary, repeat the adjustment of O307 and O305 until the end positioning is correct.

5.3.5.3.2 GEAR MESHING. If the mesh of gears O307 and O305 appears loose or if the backlash appears excessive, remove the subassembly, and perform the following operations: (Refer to figure 5-29.)

a. Loosen the three Phillips-head screws securing front plate A301 to the r-f autotransformer subassembly.
b. Move front plate A301 until gears O307 and O305 are meshed for free-running with minimum backlash.
c. Tighten the three Phillips-head screws with A301 in the position determined in step b.

5.3.5.3.3 SWITCH ALIGNMENT. To align switches S303 and S304, perform the following operations; (Refer to figures 5-28 and 5-29.)

a. Rotate the coil of T301 so that the roller is between minimum and center tap.
b. Rotate T301 toward maximum, and observe switches S303 and S304; compare the results with steps c, d, and e.
c. The contacts of S303 should close when the roller of T301 reaches the center tap position ±1 turn.

Measure for continuity between J301-E and J301-H with a multimeter. When the contacts of S303 close, J301-E and J301-H should be connected.

d. Contacts 1 and 2 of S304 should close when the roller of T301 reaches a point between maximum and one turn from maximum. Measure for continuity between J301-A and J301-J with a multimeter. When S304-1 and S304-2 close, J301-A and J301-J should be connected.

e. Contacts 1 and 2 of S304 should close on contact 3 of S304 not more than 1/8 turn later than contacts 1 and 2 close. Measure for continuity between J301-A, J301-J, and the chassis of the r-f autotransformer subassembly with a multimeter. When S304-1 and S304-2 close on S304-3, J301-A and J301-J should be grounded.

f. If switch S303 requires adjustment, proceed to step g. If switch S304 requires adjustment, proceed to step h. After adjusting the switches, repeat the alignment test outlined in steps a through e.

g. To adjust switch S303, rotate T301 to the center tap position. Loosen the two Phillips-head screws securing S303 to front plate A301, and reposition the switch assembly in relation to the operating cam.

h. To adjust switch S304, rotate T301 to maximum. Loosen the two Phillips-head screws securing S304 to front plate A301, and reposition the switch assembly so that the contacts close just before the stop disc reaches the end of its travel.

5.3.5.4 SERVO-AMPLIFIER ASSEMBLY. The alignment procedures for the servo-amplifier subassembly include the alignment of switch S601 and the selection of a value for R629. These procedures are outlined in paragraphs 5.3.5.4.1 and 5.3.5.4.2.

5.3.5.4.1 SWITCH ALIGNMENT. To align switch S601, perform the following operations: (Refer to figure 5-28.)

a. Perform steps a through j of paragraph 5.2.2.5.

b. Adjust the stationary contacts of S601 until the test results are as stated in step g of paragraph 5.2.2.5. If positive voltage is applied, adjust the front contact; if negative voltage is applied, adjust the rear contact.

NOTE

Care should be taken after any adjustment of the contact arms to see that the travel of the center arm is not restricted by the limitations of the angular slot in the hub of B601 preventing the center arm from making contact with the contact arms.

5.3.5.4.2 SELECTION OF R629. Resistor R529 is used as part of a voltage divider for the avc circuit. The value of R629 is determined at the factory to provide optimum avc voltage to the servo amplifier. Whenever it becomes necessary to substitute either the discriminator or servo-amplifier subassembly, the avc of the servo amplifier must be checked by the test outlined in paragraph 5.2.2.7. If the results differ from those as stated in step f of paragraph 5.2.2.7, a new value of R629 must be selected. If it is found necessary to replace R629, perform the following operations:

a. Use the test setup established in paragraph 5.2.2.7.

b. Unsolder and remove resistor R629. (Refer to figure 5-8.)

c. Replace the servo-amplifier dust cover.

d. Connect the leads of a resistance decade between P203-4 and ground.

e. Complete steps c through f of paragraph 5.2.2.7.

f. Vary the decade resistance until test results are as stated in step f of paragraph 5.2.2.7.

g. Select a value of R629 as close as possible to the resistance determined in step f of this paragraph. The values available in the resistance selection chart for this purpose are 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, and 82K.

h. Turn the power off, remove the decade resistance and servo-amplifier dust cover, and solder the new R629 between the points from which the old R629 was removed.

SECTION VI
PARTS LIST

6.1 INTRODUCTION.

The parts list is broken down into six major sections according to subassemblies. These sections are the chassis and panel assembly, discriminator, r-f autotransformer, variable inductor, variable capacitor, and servo amplifier. Since many parts that are associated with a particular subassembly are located in the chassis and panel assembly, these parts will not be listed under their particular subassembly, but they will be listed under the chassis and panel assembly.

In some cases, the MOD effectivity will be found in the circuit function column. When this occurs, the part to be ordered will depend upon the MOD effectivity of the subassembly in question. For instance, a part is changed Eff. MOD 4, and the subassembly is stamped MOD 4. The new part should be ordered. If the subassembly is stamped MOD 3 or a lower number, the older part should be ordered. In cases where MOD effectivities are not listed, the parts will work with all MOD numbers.

In addition to the photographs keying out parts, reference can be made to figures 5-20, 5-21, and 5-22 in the maintenance section for keyed out parts of the variable inductor, variable capacitor, and r-f autotransformer.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
	AUTOMATIC ANTENNA TUNER 180L-2		506-1199-004
	AUTOMATIC ANTENNA TUNER 180L-3		522-0092-004
	AUTOMATIC ANTENNA TUNER 180L-3A		522-0293-004
		CHASSIS AND PANEL ASSEMBLY	
A101		CHASSIS, COUPLER, PRESSED: c/o 11 self-clinching nuts and aluminum chassis 7-7/16 in. h by 9-7/8 in. w by 10-3/16 in. lg	506-1038-002
A103		PLATE, CORNER, PANEL: aluminum, 0.064 in. thk, 5/16 in. w by 2-27/32 in. lg	506-1176-002
A104		COVER, COUPLER: aluminum, 7.282 in. by 9-29/32 in. by 10 in., mtd by six 0.156 in. dia holes	506-1196-003
A105		GUSSET, CORNER: c/o 4 captive nuts and aluminum gusset 0.064 in. thk, 5/8 in. w by 1-3/4 in. lg; 4 holes 0.203 in. dia (used in 180L-2 only)	506-3582-002
A701		PANEL, MTG, RELAY: chromate dipped aluminum, 1-11/16 in. by 6-1/32 in. by 7-9/16 in. mtd by 8 tapped 4-40 NC-2 holes irregularly spaced, two 0.187 in. dia holes spaced 3-1/8 in. c to c	506-1112-004
A704		BRACKET, RELAY: chromate dipped aluminum; 5/8 in. by 7/8 in. by 1-1/2 in.; two tapped 4-40 NC-2 mtg holes irregularly spaced	506-1117-002
A705		BRACKET, MTG, RELAY: chromate dipped aluminum, 1-7/16 in. by 2-7/32 in. by 2-11/16 in.	506-1132-003
	Eff. MOD 4	BRACKET, MTG, RELAY: chromate dipped aluminum, 1-13/16 in. by 2-7/32 in. by 2-11/16 in. (used in 180L-3 and 180L-3A)	541-3652-003

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
	C101	Antenna shunt capacitor	CAPACITOR, FIXED, CERAMIC: 100 uuf ±10%, 5000 vdcw	913-0821-00
	C701	Swr bridge	CAPACITOR, FIXED, MICA: 220 uuf ±10%, 500 vdcw	912-0519-00
	C702	Swr bridge	CAPACITOR, FIXED, MICA: same as C701	912-0519-00
	C703	Swr bridge	CAPACITOR, FIXED, MICA: 10 uuf ±10%, 500 vdcw	912-0483-00
	C704	Swr bridge	CAPACITOR, FIXED, MICA: 10 uuf ±10%, 500 vdcw	912-0432-00
R	C705		CAPACITOR, FIXED, MICA: 1500 uuf ±2%, 500 v d-c; MIL type CM30C152G03	935-4109-00
R	C706		CAPACITOR, FIXED, MICA: 1000 uuf ±2%, 500 v d-c; MIL type CM30C102G03	935-4098-00
	C707	Phasing servo B+ filter	CAPACITOR, FIXED, PAPER: 470,000 uuf ±20%, 300 vdcw	931-0630-00
	C708	Loading servo B+ filter	CAPACITOR, FIXED, PAPER: 470,000 uuf ±20%, 400 vdcw	931-0649-00
R	*C709		CAPACITOR, FIXED, ELECTROLYTIC: 5 uf ±20%, 50 v d-c at 85° C, 33.3 v d-c at 125° C; MIL type CL44CJ050MP3	184-8481-00
R	*C709		CAPACITOR, FIXED, ELECTROLYTIC: 5 uf -15 +50%, 50 v d-c at 85° C, 33.3 v d-c at 125° C; MIL type CL44CJ050TP3	184-8482-00
R	*C709		CAPACITOR, FIXED, ELECTROLYTIC: 4 uf ±20%, 60 v d-c at 85° C 40 v d-c at 125° C; MIL type CL44CK040MP3	184-8490-00
R	*C709		CAPACITOR, FIXED, ELECTROLYTIC: 4 uf -15 +50%, 60 v d-c at 85° C, 40 v d-c at 125° C, MIL type CL44CK040TP3	184-8491-00
R	*C710		CAPACITOR, FIXED, ELECTROLYTIC: 5 uf ±20%, 50 v d-c at 85° C, 33.3 v d-c at 125° C; MIL type CL44CJ050MP3	184-8481-00
R	*C710		CAPACITOR, FIXED, ELECTROLYTIC: 5 uf -15 +50%, 50 v d-c at 85° C, 33.3 v d-c at 125° C; MIL type CL44CJ050TP3	184-8482-00
R	*C710		CAPACITOR, FIXED, ELECTROLYTIC: 4 uf ±20%, 60 v d-c at 85° C, 40 v d-c at 125° C; MIL type CL44CK040MP3	184-8490-00
R	*C710		CAPACITOR, FIXED, ELECTROLYTIC: 4 uf -15 +50%, 60 v d-c at 85° C, 40 v d-c at 125° C; MIL type CL44CK040TP3	184-8491-00
	C711	Autotransformer braking circuit	CAPACITOR, FIXED, PAPER: 470,000 uuf ±20%, 300 vdcw	931-0446-00
R	*C712		CAPACITOR, FIXED, ELECTROLYTIC: 11 uf ±20%, 100 v d-c at 85° C, 66.7 v d-c at 125° C; MIL type CL44CN110MP3	184-8511-00
R	*C712		CAPACITOR, FIXED, ELECTROLYTIC: 11 uf -15 +50%, 100 v d-c at 85° C, 66.7 v d-c at 125° C; MIL type CL44CN110TP3	184-8512-00
R	*C712		CAPACITOR, FIXED, ELECTROLYTIC: 9 uf ±20%, 125 v d-c at 85° C, 83.3 v d-c at 125° C; MIL type CL44CP090MP3	184-8519-00
R	*C712		CAPACITOR, FIXED, ELECTROLYTIC: 9 uf -15 +50%, 125 v d-c at 85° C, 83.8 v d-c at 125° C; MIL type CL44CP090TP3	184-8520-00
	C713	R-f filter	CAPACITOR, FIXED, CERAMIC: 0.005 uf +100% -20%, 500 vdcw (used in 180L-3 and 180L-3A)	913-1187-00

*Selected in test

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C713		CAPACITOR, FIXED, PAPER: 100,000 uuf ±20%, 100 vdcw	931-2503-00
C714	R-f filter	CAPACITOR, FIXED, CERAMIC: 0.005 uf +100% -20%, 500 vdcw (used in 180L-3 and 180L-3A)	913-1187-00
C715	Eff. MOD 3	CAPACITOR, FIXED, PAPER: 100,000 uuf ±20%, 100 vdcw	931-2503-00
CR701	Swr meter rectifier	CRYSTAL UNIT, RECTIFYING: germanium, 80 peak inverse v, 35 ma average current, 1 uuf shunt capacitance	353-0098-00
E101	Antenna insulator	INSULATOR, ANTENNA TERMINAL: rectangular, ceramic (used in 180L-2 only)	506-3053-002
E101	Antenna insulator	INSULATOR, TERMINAL: rectangular, 440A molded fiber glass (used in 180L-3 and 180L-3A)	540-5120-003
E102	Antenna terminal	POST, BINDING: phenolic cap w/black finish, screw action, knurled, nonremovable cap; brass bushing; 0.798 in. approx overall, 0.767 in. dia	506-1188-002
	Effective serial no. 180L-2, 2452 180L-3, 1253	POST, BINDING: screw type; 0.905 in. lg by 0.500 in. dia overall; #8-32 NC-2 by 0.219 in. lg mtg stud; brass, nickel plated	372-1540-00
E103	Antenna connector	CONNECTOR, COLLET: brass; silver plated (used in 180L-2 only)	506-3055-002
E103	Antenna contact	NUT, HEXAGON: brass, silver plated chamfered corners, #8-32 NC-2, 4 full threads (used in 180L-3 and 180L-3A)	506-1187-002
E701	K710 relay arm	CONTACT ASSEMBLY, RELAY: c/o spring term w/ two contacts riveted to insulating arm; beryllium copper; silver contacts; thermosetting plastic arm; ID hub w/two #4-48 NF-2 tapped holes spaced 90° apart	540-9976-002
		OR	
		RELAY, ARM: c/o 1 contact arm, 1 contact arm terminal and hardware; 0.525 in. by 0.750 in. by 2.656 in.	541-4911-002
	Eff. serial no. 180L-2, 2855; 180L-3, 5315; 180L-3A 371	ARM, RELAY: c/o ceramic type 205 high aluminated 1/4 in. w by 2.093 in. lg; copper terminal spring, brass hub 0.625 in. dia by 0.525 in. w, plus hardware (used in 180L-3 and 180L-3A)	542-5663-002
		OR	
		ARM, RELAY: c/o ceramoplastic supramica type 500 arm 1/4 in. w by 2.093 in. lg; copper terminal spring; brass hub 0.625 in. dia by 0.525 in. w, plus hardware (used in 180L-3 and 180L-3A)	542-5664-002
E703	Transfer relay	CONTACT RELAY: antenna; c/o spring terminal w/ solder lug staked to one end and coin silver contact to other end (used in 180L-3 and 180L-3A) (p/o K712)	506-1130-002
E704	Transfer relay receiver contact	CONTACT RELAY: antenna; c/o spring terminal w/ solder lug staked to one end and coin silver contact staked to other end (used in 180L-3 and 180L-3A) (p/o K712)	506-1131-002
E705	Receiver terminal ground contact	CONTACT, RELAY: spring leaf type; single flat contact (used in 180L-3 and 180L-3A)	540-1339-002
H701		POST, SPACING: chromate dipped aluminum; 3/16 in. hex by 2.406 in. lg; ea end tapped 4-40 NC-2, 5/16 in. deep	506-1123-002
H702		SPACER, SLEEVE: brass, 0.051 in. thk by 1/4 in. OD by 0.250 in. lg	500-5009-001

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
H703		STANDOFF: brass; 3/16 in. hex by 0.437 in. lg; ea end tapped 4-40 NC-2, 1/2 in. deep	500-6219-001
J101	R-f input connector	CONNECTOR, RECEPTACLE, ELECTRICAL: single round female contact	357-9005-00
J102	Power input connector	CONNECTOR, RECEPTACLE, ELECTRICAL: 16 round female polarized contacts	371-3060-00
J103	Receiver connector	CONNECTOR, RECEPTACLE, ELECTRICAL: single round female polarized contacts (used in 180L-3 and 180L-3A)	540-1337-002
K701	Coil-capacitor switching	RELAY, ARMATURE: 2.0 amp, 27.5 v d-c; 280 ohm ±10%, d-c resistance	974-0291-00
K702	Homing	RELAY, ARMATURE: same as K701	974-0291-00
K703	Capacitive error	RELAY, ARMATURE: same as K701	974-0291-00
K704	Inductive error	RELAY, ARMATURE: same as K701	974-0291-00
K705	Minimum reverse	RELAY, ARMATURE: same as K701	974-0291-00
K706	Maximum reverse	RELAY, ARMATURE: same as K701	974-0291-00
K707	Retune information	RELAY, ARMATURE: same as K701	974-0291-00
K708	Automatic keying	RELAY, ARMATURE: same as K701	974-0291-00
K709	Loading error	RELAY, ARMATURE: 1.0 amp, 27.5 v d-c; 5000 ohm ±10% d-c resistance	974-0340-00
K710		RELAY, ROTARY: 2 sections, spst; 28 v d-c; 4 amp; 1 tapped winding, 7.5 ohm start, 260 ohm hold	506-1142-003
K710	Antenna shunt "C"	RELAY, ROTARY: 1.0 amp, 27.5 v d-c; 7.5 ohm start, 260 ohm hold, ±10% d-c resistance	410-0100-00
K711	Protective time delay	RELAY, THERMAL: 6 amp; single wound, 22-30 v operating; time delay 30 seconds ±3%	402-0217-00
		BASE, RELAY: aluminum; socket type mtg to item supported; two tapped 4-40 NC-2 mtg holes on bottom; incl relay base w/tube socket, 2 spacing posts, 2 screws and 2 lock washers; mtg plate for K711	506-1121-002
K712	Antenna transfer relay	C/O E703, E704, L703, S701	
K713	Antenna ground relay	RELAY, ARMATURE: 2.0 amp, 28 v d-c, 500 ohms ±10% d-c resistance (used in 180L-3A only)	974-0535-00
L701	Swr r-f choke	COIL, RADIO FREQUENCY: 4 windings, universal wound, unshielded; 8.2 mh ±10% at 1000 cps; 235 turns #36 SSC copper wire per winding	240-0046-00
L702	Swr r-f choke	COIL, RADIO FREQUENCY: single wound, 3 pie universal wound; unshielded 1 mh, approx 156 turns #36 AWG wire each pi	240-0047-00
L703	Antenna transfer relay solenoid	SOLENOID: antenna relay; 28.5 v d-c nom operating v, 55 ohm ±20%, d-c resistance (used in 180L-3 and 180L-3A) (p/o K712)	410-0092-00
L704	R-f filter	COIL, RADIO FREQUENCY: single wound, 3 layers, unshielded; 7.5 mh ±10% at 7.9 mc; 71 turns #28 AWG copper wire, first layer 26 turns, second layer 24 turns, third layer 21 turns	240-0098-00
M701	Swr indicator meter	METER: ammeter; d-c; range 0 to 2 ma d-c; 3T accuracy for full scale reading; 27 ohm ±20%; 0 to 10 scale	458-0164-00
O103		GASKET: cork and sponge rubber, 1/32 in. thk; 3/8 in. ID, 9/16 in. OD	506-1184-00
O103	Eff. serial no. 180L-2, 2452; 180L-3, 1252	GASKET, BINDING POST: cork and rubber synthetic rubber composition, 1/32 in. thk, 0.312 in. ID, 0.562 in. OD (used in 180L-2 only)	540-1012-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
O105		GASKET: cork and sponge rubber composition, rectangular w/rounded corners; 2.125 in. w by 4.500 in. lg aperture; 1/16 in. by 2-3/8 in. by 4-7/8 in. overall; 7/16 in. outside corner radius (used in 180L-3 and 180L-3A)	540-1336-002
O105		GASKET, BOWL INSULATING: cork and sponge rubber, 1/16 in. thk; 2-1/2 in. w by 4-5/8 in. lg; 4 mtg holes 5/32 in. dia (used in 180L-2 only)	506-1185-002
O701		CAP, ELECTRICAL: beryllium copper; 0.145 in. by 0.812 in. by 1.437 in.; two 0.140 in. dia mtg holes spaced 1.125 in. c to c	506-1122-002
P101	R-f input plug	CONNECTOR, PLUG: single round male contact OR	357-9006-00
	R-f input plug	CONNECTOR, PLUG: single round female contact	357-9014-00
P102	Power input plug	CONNECTOR, PLUG: 16 round female polarized contacts	371-3070-00
P103	Auxiliary receiver terminal	CONNECTOR, PLUG: pin insert weatherproof	357-9018-00
P201	Discriminator r-f input connector	CONNECTOR, PLUG: single round male contact	357-9101-00
P202	Transformer output connector	PLUG, TRANSFORMER: phenolic board; brass silver plated plug; beryllium copper spring	506-1162-002
P203	Discriminator output connector	CONNECTOR, PLUG: four banana-type terminals spun to board	506-1047-002
P301	Autotransformer power connector	CONNECTOR, PLUG: 9 round female polarized contacts	372-1125-00
P401	Variable inductor power connector	CONNECTOR, PLUG: 15 round female polarized contacts	371-0019-00
P501	Variable capacitor power connector	CONNECTOR, PLUG: 15 round female polarized contacts	371-0019-00
P601	Servo power connector	CONNECTOR, PLUG: 15 round female polarized contacts	371-0019-00
R104		RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 1/2 w	745-1394-00
R107		RESISTOR, FIXED, COMPOSITION: same as R104	745-1394-00
R701 thru R710	Swr bridge	RESISTOR, FIXED, COMPOSITION: 10 ohms ±10%, 1 w	745-3268-00
R711	Swr meter filter network	RESISTOR, FIXED, COMPOSITION: 470 ohms ±10%, 1/2 w	745-1338-00
R712	Swr meter filter network	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 1/2 w	745-1394-00
R713	Loading servo B+ dropping resistor	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 2 w (nonpreferred)	745-9139-00
	Eff. serial no. 180L-2, 2438; 180L-3, 661	RESISTOR, FIXED, WIREWOUND: 10,000 ohms ±3%, 5 w	747-9410-00
R714	Phasing servo B+ dropping resistor	RESISTOR, FIXED, COMPOSITION: 15,000 ohms ±10%, 2 w (nonpreferred)	745-9146-00
	Eff. serial no. 180L-2, 2438; 180L-3, 661	RESISTOR, FIXED, COMPOSITION: 15,000 ohms ±10%, 2 w	745-5701-00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R715	Loading servo B+ bleeder	RESISTOR, FIXED, COMPOSITION: 39,000 ohms ±10%, 2 w (nonpreferred)	745-9164-00
	Eff. serial no. 180L-2, 2438; 180L-3, 661	RESISTOR, FIXED, COMPOSITION: 39,000 ohms ±10%, 2 w	745-5719-00
R716	K709 bleeder	RESISTOR, FIXED, COMPOSITION: 82,000 ohms ±10%, 1/2 w (nonpreferred)	745-1167-00
		RESISTOR, FIXED, COMPOSITION: 82,000 ohms ±10%, 1/2 w	745-1433-00
R717	K709 bleeder Eff. MOD 1	RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%, 2 w (nonpreferred)	745-9153-00
		RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%, 2 w	745-5708-00
R718	Current limiting resistor Eff. MOD 3	RESISTOR, FIXED, COMPOSITION: 270 ohms ±10%, 1 w	745-3328-00
R719	Static drain resistor	RESISTOR, FIXED, COMPOSITION: 1 megohm ±10%, 1 w	745-3478-00
	Eff. MOD 4	RESISTOR, FIXED, COMPOSITION: 2. 2 megohms ±20%, 1/2 w (used in 180L-3 and 180L-3A)	745-1493-00
R720	Static drain resistor	RESISTOR, FIXED, COMPOSITION: 2. 2 megohms ±20%, 1/2 w (used in 180L-3 and 180L-3A)	745-1493-00
S701	Antenna transfer relay switch	SWITCH, RELAY: spdt; within a high vacuum; 20,000 v radio freq peak, 1-1/8 amp at 5,000 v; 0. 015 contact spacing (used in 180L-3 and 180L-3A) (p/o K712)	260-0900-00
S703	Motor thermostat	SWITCH, THERMOSTATIC: bi-metallic disc type thermostatic switch; opening temp -20° C max; closing temp, -35° C min; ambient temp range; -60° C to +85° C	292-0117-00
TB701	Swr terminal board	TERMINAL BOARD: general purpose, 12 brass silver plated terminals; irregularly spaced; plastic board	506-1045-002
TB702	Relay terminal board	TERMINAL BOARD: staked; plastic board, brass silver plated terminals	540-5338-002
TB703	R-f filter board	TERMINAL BOARD: brass, silver plated terminals, plastic board (used in 180L-3 and 180L-3A)	540-2877-002
TB704	Switching terminal board	TERMINAL BOARD: staked; 14 brass silver plated post terminals; irregularly spaced; plastic board	540-5303-002
TB705	Tie point Eff. MOD 4	TERMINAL BOARD: plastic board, 3 terminals turret type, brass, silver plated	541-3649-002
W701	Power and control circuit cable	CABLE ASSEMBLY, POWER: one #20 bus, 20 colors #22, one #18 stranded conductor; insulated	506-4406-002
W702	R-f lead	CABLE, R. F.: coaxial, 29 uuf per ft, 53. 5 ohm normal impedance 1900 v rms; #20 AWG solid plain copper wire	506-1048-002
XK701	K701 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK702	K702 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK703	K703 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK704	K704 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK705	K705 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK706	K706 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK707	K707 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK708	K708 socket	SOCKET, TUBE: 14 contact	220-1166-00
XK709	K709 socket	SOCKET, TUBE: 9 contact	220-1169-00
XK711	K711 socket	SOCKET, TUBE: 7 contact miniature	220-1044-00
XK713	K713 socket Eff. MOD 4	SOCKET, TUBE: 7 contact miniature	220-1046-00
XK713		SOCKET, TUBE: 7 contact miniature (used in 180L-3 and 180L-3A)	220-1235-00

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
		DISCRIMINATOR		540-5676-003
R	A201		CHASSIS, ELECTRICAL, EQUIPMENT:	549-1062-004
R	A202		PLATE: aluminum, chromate dip finish; 0. 040 in. by 1. 687 in. 2. 937 in.	506-1144-002
R	A203		PLATE: aluminum, chromate dip finish; 0. 281 in. by 1. 782 in. by 3. 095	206-1145-002
R	C201	Eff. MOD 2	CAPACITOR, FIXED, CERAMIC: 15 uuf ±20%, 2000 vdc P/O T201	913-4506-00
	C202	Phase discriminator voltage divider	CAPACITOR, FIXED, MICA: 100 uuf ±20%, 500 vdcw	912-0720-00
	C203	Phase discriminator r-f ground and load filter	CAPACITOR, FIXED, PAPER: 10,000 uuf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0349-00
	C206	Phase discriminator output filter	CAPACITOR, FIXED, PAPER: same as L203	931-0349-00
	C207	Loading discriminator current sampler isolation	CAPACITOR, FIXED, MICA: 470 uuf ±10%, 300 vdcw	912-0543-00
	C208	Loading discriminator current sampler isolation	CAPACITOR, FIXED, MICA: same as C207	912-0543-00
	C209	Loading discriminator current sampler load filter	CAPACITOR, FIXED, PAPER: same as C203	931-0349-00
R	C210	Eff. MOD 2	CAPACITOR, VARIABLE, GLASS: 0. 8 uuf to 8. 5 uuf, 1250 v d-c; JFD Electronics Corp. part no. SC-153	922-0642-00
R	C211	Eff. MOD 2	CAPACITOR, FIXED, PAPER: 0. 01 uf ±20%, 100 v d-c; Sprague Electric Co. part no. 96P10301S4	931-2497-00
R	C212	Loading discriminator voltage sampler load filter Eff. MOD 2	CAPACITOR, FIXED, PAPER: same as C211	931-2497-00
R	C213	Loading discriminator output filter Eff. MOD 2	CAPACITOR, FIXED, PAPER: same as C211	931-2497-00
R	C214	Loading discriminator voltage sampler load filter Eff. MOD 2	CAPACITOR, FIXED, PAPER: same as C211	931-2497-00
	C215	Avc load filter	CAPACITOR, FIXED, PAPER: same as C203	931-0349-00
	C216	Avc output filter	CAPACITOR, FIXED, PAPER: same as C203	931-0349-00
R	CR201	Eff. MOD 2	SEMICONDUCTOR DEVICE, SET: matched pair	544-2567-00
R	CR202	Eff. MOD 2	SEMICONDUCTOR DEVICE, SET: same as CR201	544-2567-00
R	CR203	Eff. MOD 2	SEMICONDUCTOR DEVICE, SET: same as CR201	544-2567-00
R	CR204	Eff. MOD 2	SEMICONDUCTOR DEVICE, SET: same as CR201	544-2567-00
	CR205	Avc detector	CRYSTAL UNIT, RECTIFYING: germanium; 80 peak inverse v, 35 ma average current; 1. 0 uuf shunt capacitance	353-0098-00
	E201	Discriminator transformer shield	SHIELD, TRANSFORMER: aluminum chromate dipped; square shaped; 1-15/16 in. lg by 1-19/32 in. w by 1-3/16 in. thk overall	506-1146-002
	E202	Discriminator r-f output	TERMINAL, STUD: brass, silver plated (p/o T201)	506-1149-002
	H201		SPACER: Plastic; 1/16 in. by 1/4 in. by 9/16 in.; two 0. 125 in. dia mtg holes spaced 0. 312 in. c to c	506-0831-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
J201	Discriminator r-f input connector	CONNECTOR, RECEPTACLE, ELECTRICAL: single round female contact (p/o T201)	357-9100-00
J202	Transformer output connector	CONNECTOR, RECEPTACLE, ELECTRICAL: four solder terminals spun into board	506-1164-002
J203	Discriminator output connector	CONNECTOR, RECEPTACLE, ELECTRICAL: four solder lug terminals spun into board	506-1165-002
L201	Phasing discriminator output filter	COIL, RADIO FREQUENCY: 3 pi universal wound; unshielded; approx 220 uh, approx 75 turns of #36 S copper wire each section	240-0037-00
L202	Loading discriminator current sampler detector d-c return	COIL, RADIO FREQUENCY: same as L201	240-0037-00
L204	Loading discriminator current sampler detector d-c return	COIL, RADIO FREQUENCY: same as L201	240-0037-00
L205	Loading discriminator output filter	COIL, RADIO FREQUENCY: same as L201	240-0037-00
R202	Phasing discriminator detector load	RESISTOR, FIXED, COMPOSITION: 18,000 ohms ±10%, 1/2 w	745-1405-00
R203	Phasing discriminator detector load	RESISTOR, FIXED, COMPOSITION: same as R202	745-1405-00
R204	Loading discriminator current sampler detector load	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 1/2 w	745-1394-00
R205	Loading discriminator voltage sampler voltage divider	RESISTOR, FIXED, COMPOSITION: 180 ohms ±10%, 1/2 w	745-1321-00
R206	Loading discriminator voltage sampler detector load	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 1/2 w	745-1394-00
R207	Avc detector load	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%, 1/2 w	745-1394-00
R208	Avc voltage divider	RESISTOR, FIXED, COMPOSITION: 47,000 ohms ±10%, 1/2 w	745-1422-00
R209	Loading discriminator current sampler output filter	RESISTOR, FIXED, COMPOSITION: 4700 ohms ±10%, 1/2 w	745-1380-00
T201	Discriminator transformer	TRANSFORMER, DISCRIMINATOR: tuned primary and secondary; toroidal core tuning; brass silver plated primary terminal on one side; four banana-type terminals on bottom; (includes C201, E202, and J201)	506-1157-002
TB201	Discriminator terminal rear board	TERMINAL BOARD: staked; 11 brass silver plated post terminals; irregularly spaced; natural phenolic	506-1158-002
TB202	Discriminator center terminal board	TERMINAL BOARD: staked; six brass silver plated terminals; irregularly spaced	506-1159-002
R TB203	Discriminator front terminal board Eff. MOD 2	TERMINAL BOARD: plastic; 0.093 in. by 1.437 in. by 1.750 in.; incl 6 terminal posts and tubelets	549-1059-003

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
		R-F AUTOTRANSFORMER		541-3639-002
R	A301		CHASSIS, ELECTRICAL EQUIPMENT: aluminum, chromate dip finish; 1.937 in. by 2.311 in. by 3.017 in.	549-1062-004
	A302	Center gear plate	PLATE, GEAR, SPUN: incl brass eyelet; Oilite bearing; 2 post #303 stainless steel; plate aluminum irregularly spaced	540-2849-002
	A303	Rear plate	PLATE, REAR, TRANSFORMER: plastic; 3/16 in. by 2-9/16 in. by 3-13/16 in.; five 0.152 in. dia holes irregularly spaced for mtg	540-2844-002
	A304		BRACKET, ANGLE: chromate dipped aluminum; 5/16 in. by 1/2 in. by 1-3/16 in.; mtd by two 4-40 self-clinching nuts spaced 0.625 in. c to c	506-0856-002
R	B301		MOTOR CONTROL: 115 v a-c to fixed phase, up to 115 v a-c to control phase for series operation, 4800 rpm, no-load, 2800 rpm at max power output; 1.4 oz in. min at stall, 0.75 oz in. at 2800 rpm; 6.8 v input, 1.5 v output; 2200 ohms series connected, 550 ohms parallel connected control phase; 1.437 in. dia by 1.671 in. lg; Avionic Division John Oster Mfg. Co. part no. 5153-16-01	229-0126-00
	C301	Loading servo variable phase tuning	CAPACITOR, FIXED, PAPER: 330,000 uuf ±10%, 120 vdcw	931-2241-00
	E301	Autotransformer r-f input contact	CONTACT, COIL: terminal soldered; incl 1 terminal for coil; terminal copper, silver plate and contact coin silver	506-0875-002
	E302	Autotransformer r-f input connector	JACK, TERMINAL: brass, silver plated; cylindrical 13/32 in. lg by 5/16 in. OD; radially tapped 4-48 NF-2 to center for mtg; tapped #4-40 NC-2 by 3/16 in. deep	506-0854-002
	E303	Autotransformer r-f output	BRUSH, ELECTRICAL CONTACT: for transformer; c/o shaft w/two terminal bars and pickup wheel	506-0873-002
	E304	Mounting for C301	TERMINAL LUG: double end, brass, silver plated	306-0203-00
	E305	Mounting for C301	TERMINAL LUG: double end; brass, silver plated	306-0203-00
	E306	Eff. MOD 3	CONTACT, ELECTRICAL: phosphor bronze, 0.068 in. by 1/2 in. by 1-1/2 in.	542-6900-003
	H301		STANDOFF: anodized aluminum; 1/4 in. hex by 0.875 in. lg; ea end tapped 6-32 NC-2, 3/8 in. deep	500-2752-001
	H302	Eff. MOD 3	STANDOFF: aluminum; 1/4 in. hex by 0.875 in. lg; tapped 6-32 NC-2B by 3/8 in. ea end; w/notch	542-6902-002
	J301	Autotransformer power connectors	CONNECTOR, PLUG: 9 round male polarized contacts	372-1123-00
	O301		ROD, PIVOT: plastic; 3/8 in. dia by 3-1/16 in. lg overall; 4 tapped 4-40 NC-2 through holes, ea end undercut	506-0835-002
	O302	Autotransformer gear train	GEAR ASSEMBLY: soldered; incl one 144-tooth gear and one 33-tooth gear; 33-tooth gear, bronze, 144 tooth gear commercial brass	506-0870-002
	O303		POST, GEAR: passivated steel; 3/8 in. OD by 3/32 in. lg; 0.250 in. dia by 0.170 in. lg for mtg	506-0842-002
	O304	Autotransformer gear train	GEAR ASSEMBLY: soldered; incl one 72 tooth gear and one 17 tooth gear; 72 tooth gear commercial brass, and 17 tooth gear phosphor bronze	506-0869-002
	O305	Autotransformer gear train	GEAR ASSEMBLY: soldered; incl one 107 tooth gear and one 21 tooth gear; 21 tooth gear; phosphor bronze, and 107 tooth gear commercial brass	506-0868-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
O306		POST, GEAR: passivated steel; 3/8 in. OD by 39/64 in. lg; 0. 250 in. dia by 0. 115 in. lg for mtg	506-0846-002
O307	Autotransformer gear train	GEAR, SPUR: commercial brass gear, ring stainless steel, straight; 103 tooth	506-0867-002
	Eff. MOD 3	GEAR, CAM ASSEMBLY: c/o 1 plastic cam and 1 bronze gear w/103 teeth, 20° pressure angle, 1. 6093 in. pitch dia, 0. 460 in. by 1. 679 in. by 1. 679 in. overall	543-0468-002
O308		POST, GEAR: passivated steel; 3/8 in. OD by 0. 671 in. lg; 0. 250 in. dia by 0. 143 in. lg for mtg	506-0858-002
O309		CONTACT, ELECTRICAL: coupler subassembly; one yellow brass point, 0. 187 in. dia by 0. 109 in. h; brass, silver plated contact surface; 1-5/8 in. dia by 1/4 in. thk	506-3206-002
	Eff. MOD 3	ACTUATOR, SWITCH: c/o 1 switching disc, 1 hub and 1 limit ring; 1-5/16 in. OD by 1/4 in. h	542-6906-003
O310		PIN, STOP, DISC, steel; 3/8 in. OD by 11/32 in. lg; 0. 188 in. dia by 0. 140 in. lg for mtg	506-0851-002
O311		PIN, STOP, DISC: same as O310	506-0851-002
O312		SPRING, PICKUP ROD: beryllium copper; 0. 0126 in. by 13/16 in. by 1 in. ; two 0. 125 in. dia mtg holes spaced 0. 500 in. c to c	540-2845-002
O313		BEARING, SLEEVE: bronze; 0. 250 in. max ID, 0. 381 in. max OD body, 0. 255 in. max lg; 0. 5025 in. max dia by 0. 0650 in. w flange	309-0120-00
O314		BEARING, SLEEVE: bronze; 0. 250 in. max ID, 0. 381 in. max OD, 0. 1925 in. max lg; 0. 5025 in. max OD by 0. 0650 in. max w flange	309-0127-00
O315		SPRING, HELICAL EXTENSION: steel music wire; 9/64 in. ID, 0. 156 in. OD, 5/16 in. free lg; 11/64 in. lg overall; rh wound	340-2090-00
O316		SPRING, HELICAL EXTENSION: same as O315	340-2090-00
R301	Loading servo fixed phase shunt	RESISTOR, FIXED, WIREWOUND: 3100 ohms ±5%, 12 w	747-1139-00
S301	Control circuit switch	SWITCH: c/o switch terminal w/contact staked to end; beryllium copper ternary plated (copper, tin and zinc) terminal, silver contact	506-0876-002
S304	Eff. MOD 3	CONTACT ASSEMBLY, ELECTRICAL: 1 C; 5/16 in. by 9/16 in. by 1-7/32 in. overall	269-1877-00
S302	Control circuit switch	SWITCH, SENSITIVE: spst, normally open; 1 amp 28 v d-c resistive load	269-1606-00
S303	Eff. MOD 3	CONTACT ASSEMBLY, ELECTRICAL: 1B; 21/32 in. by 23/32 in. by 1. 125 in. overall	269-1878-00
T301	Autotransformer coil	COIL, RF: single wound, single layer wound, unshielded; 28 turns per inch	506-9527-004
	Eff. MOD 3	TRANSFORMER, RADIO FREQUENCY: 2 windings #18 AWG silver coated copper wire; ceramic coil form; uncased; 1. 750 in. dia by 3. 420 in. lg overall	542-6909-004
	R-F VARIABLE INDUCTOR		540-9957-005
A401	Bottom gear plate	PLATE, BOTTOM: pressed; incl 4 bearings, 5 posts, 1 stop; 1 cup and one bearing; irregularly spaced	540-9947-003

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
A402	Top plate	PLATE, COVER: pressed; incl 2 bearings; bearings bronze; plate cast thermosettings plastic irregular shape	540-9949-003
A404		GUSSET, COIL: plastic; 1/4 in. by 1-7/8 in. by 5. 375 in. ; four tapped 6-32 holes 7/16 in. deep, 2 ea end spaced 1. 250 in. c to c for mtg	540-9942-004
B401	R-f variable inductor drive motor	MOTOR, D-C: permanent magnet type; 1/100 hp nom output; no load speed, 21,000 rpm, closed frame	230-0197-00
E401	L401 shorting drum	DRUM, COIL: aluminum chromate dipped; cylindrical	506-0948-002
E402	L401 tape	WIRE, ELECTRICAL: full hard drawn fine silver ribbon; 288 in. lg by 0. 125 in. w by 0. 010 in. thk	998-0022-00
E403	L401 ceramic drum	FORM, COIL: ceramic; 5. 406 in. lg by 3. 375 in. dia overall; grooved; mtd by shaft 1. 437 in. dia hole	506-1026-002
E404	Contact and shaft for E401	PLATE, FRONT: drum, staked; incl shaft; shaft copper plate aluminum chromate dipped	506-1016-002
E405	L401 r-f output contact	ARM: r-f; incl contact; contact coil silver; arm copper silver plated; irregularly spaced	506-1009-002
E406	L401 r-f output connector	CONTACT, CONNECTOR: aluminum; chromate dipped; round; radially tapped 4-48 NF-2	506-0995-002
E407	L401 r-f input contact	ARM: rf; same as E405	506-1009-002
E408	L401 r-f input connector	CONTACT, CONNECTOR: same as E406	506-0995-002
E409	L401 iron core	CORE ASSEMBLY, COIL: three tuning cores included in holder; powdered iron cores and plastic holder; frequency range 2 mc to 25 mc; cylindrical	506-1019-002
E410	Contact and shaft for E403	SHAFT: contact soldered; incl a terminal and contact, terminal and shaft copper; contact coin silver; irregularly shaped	506-1008-002
E411	Tape storage drum assembly	GEAR, SPUR: plastic paper base, drum stainless steel; involute teeth; 120 teeth; 32 diametral pitch	506-1031-003
E412	Variable inductor drum assembly	FORM, COIL: includes gear and contact shaft ceramic drum; resin coated, paper base plastic gear; 32 pitch, 120 teeth	506-1033-003
J401	Variable inductor power connector	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 round female contacts	371-0020-00
L401	R-f variable inductor	C/O E401, E402, E403, E404, E409, E410	
O402	Variable inductor gear train		506-1023-002
O402	Eff. MOD 1	GEAR ASSEMBLY: soldered; includes one 96 tooth gear and one 32 tooth gear; 96 tooth gear brass, 32 tooth gear steel, type 303 passivated	540-5365-002
O403		POST, GEAR: steel; passivated finish; 0. 2495 in. dia by 23/32 in. lg; one end tapped 6-32; 5/16 in. deep for mtg	540-9945-002
O404	Variable inductor gear train	GEAR ASSEMBLY: soldered; includes one 80 tooth and one 24 tooth gear; 80 tooth gear brass, 24 tooth gear stainless steel, type #303	540-9941-002
O405		POST, GEAR: same as O403	540-9945-002
O406	Variable inductor gear train	GEAR, SPUR: 100 teeth, 20° pressure angle; 2. 125 in. OD gear, 2. 083 in. pitch dia, 0. 093 in. w face, 0. 281 in. over-all length; one tapped 4-48 and one 0. 047 in. dia hole spaced 90° apart on hub for securing	506-0979-002
	Eff. serial no. 180L-2, 2674; 180L-3, 4839; 180L-3A, 66	GEAR, SPUR: phosphor bronze; 100 teeth, 20° pressure angle	541-5209-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
O407		GEAR - SHAFT ASSEMBLY: c/o 1 shaft, 1 stop pin holder and 1 gear; gear 24 teeth, 20° pressure angle; 0. 500 in. pitch dia; 0. 874 in. by 1-1/4 in. by 1-9/16 in. ; three hole mtg by 0. 312 in. dia, 1/4 in. lg	506-1010-003
O408	Variable inductor gear train	GEAR ASSEMBLY: soldered; incl one15 tooth, and one 48 tooth gear; 15 tooth gear steel type #302, 48 tooth gear	506-1017-002
O409		BEARING, SLEEVE: cylindrical w/flange; porous bronze 0. 376 in. max ID, 0. 505 in. max OD, 0. 220 in. max overall lg, 0. 5625 in. max OD by 0. 031 in. max w flange	506-0968-002
O410	Variable inductor gear train	GEAR ASSEMBLY: soldered; incl one 15 tooth gear and one 60 tooth gear; 15 tooth gear steel type #302, 60 tooth gear brass	506-1018-002
O411		BEARING, SLEEVE: same as O409	506-0968-002
O412		RACE, BEARING, OUTER: annular roller; ground; 0. 531 in. bore dia; 0. 625 in. OD; flanged, 0. 870 in. OD by 0. 065 in. w flange; 0. 250 in. lg overall	506-0994-002
O413	Variable inductor gear grain	GEAR, SPUR: anodized aluminum; idler; straight teeth; 36 teeth; straight face	506-0955-002
O414		POST, IDLER: type 303 corrosion-resistant steel, passivated; 5/16 in. dia by 0. 500 in. lg; undercut and grooved; 0. 1895 dia for thru hole mtg	506-0958-002
O415		WASHER, NONMETALLIC: cylindrical; plastic; 1. 406 in. max ID, 1. 625 in. max OD, 0. 106 in. max overall length	506-0956-002
O416		BEARING, SLEEVE: cylindrical w/flange; bronze 0. 313 in. max ID, 0. 447 in. max OD, 0. 314 in. overall lg; 0. 500 in. max OD flange, 0. 062 in. max w flange	506-0971-002
O417	Variable inductor gear train	GEAR, SPUR: commercial brass; straight teeth; 49 teeth	506-1015-002
O418		SHAFT, SWITCH: type 303 corrosion-resistant steel, passivated; 0. 250 in. by 0. 187 in. by 1 in. ; 0. 250 in. OD, flatted two sides to 0. 187 in. w for mtg	506-0953-002
O419		ARM, ROLLER: type 302 corrosion-resistant steel, passivated; 0. 062 in. by 7/16 in. by 1. 828 in. ; 0. 312 in. dia hole for mtg	506-0987-002
O420		DETENT, CAM: steel; 1/2 in. by 1. 089 in. by 1. 468 in.	506-1022-002
O421		BEARING, SLEEVE: cylindrical w/flange; CRES, 0. 126 in. max ID body, 0. 2535 in. max OD body; 0. 285 in. max overall lg; 3/8 in. OD by 0. 032 in. w flange; undercut	506-0984-002
O422		POST, CAM SPRING: brass; 0. 095 in. dia by 7/16 in. lg; one end grooved to 0. 046 in. w by 0. 015 in. deep and other end knurled 1/4 in.	506-0990-002
O423		POST, CAM SPRING: same as O422	506-0990-002
O424		SPRING, HELICAL EXTENSION: steel wire, 0. 010 in. dia; 18 coils, close wound; cylindrical; 0. 125 in. OD by 0. 52 in. approx lg; no load, 1. 2 in. max lg at 38 lb	506-0991-002
O425		SPRING, HELICAL EXTENSION: same as O424	506-0991-002
O426		STOP, CAM: type 303 CRES; 3/16 in. dia by 7/16 in. lg; undercut and knurled to 0. 127 in. dia one end; 0. 127 in. dia for thru hole mtg	506-0992-002
O427		STOP, CAM: same as O426	506-0992-002
O428	Variable inductor gear train	GEAR, SPUR: PBG plastic paper base; idler; involute teeth; 56 teeth; straight face	506-0966-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
O429		POST, IDLER GEAR: brass, alloy plated; undercut and grooved; 3/8 in. dia by 3/4 in. lg; 0.2508 in. dia for thru hole mtg	506-0967-002
O430		BEARING, SLEEVE: bronze; impregnated; 0.313 in. ID, 0.562 in. OD, 0.271 in. lg	506-0997-002
O431		BEARING, SLEEVE: same as O430	506-0997-002
O432		GEAR, SPUR: plastic; 120 teeth, 20° pressure angle; 3.812 in. OD, 3.750 in. pitch dia; 3/32 in. w face	506-1004-002
O432	Variable inductor gear train	GEAR, SPUR: type PBG plastic paper base; loading; involute teeth; 120 teeth; straight face; post steel type #303	540-2712-002
O434		PLATE, MOUNTING: chromate dipped aluminum; 0.064 in. by 1/2 in. by 1-1/4 in.; mtd by three holes 2 tapped 4-40 NC-2 and one 0.140 in. dia spaced 0.437 in. c to c	506-1013-002
O435		PLATE, MOUNTING: same as O434	506-1013-002
O436		SPRING, HELICAL EXTENSION: 0.150 in. w hook, 1/4 in. lg from coil to inside of hook, 3/32 in. radius of hook; loops centered and parallel; 5/8 in. lg of coils; 1-1/8 in. lg inside hooks; 0.235 in. OD of spring; 3/16 in. ID of spring 1.298 in. over-all length	506-0996-002
O437		SPRING, HELICAL EXTENSION: same as O436	506-0996-002
O438		PIN, GEAR LOAD: passivated steel; 3/16 in. OD by 0.282 in. lg; mtd by 0.094 in. dia, 0.120 in. lg	506-1003-002
O439		PIN, GEAR LOAD: same as O438	506-1003-002
O440		PIN, DRUM LOAD: passivated steel, 0.250 in. OD by 0.366 in. lg; mtd by 0.187 in. dia; 0.080 in. lg	506-1002-002
O441		PIN, DRUM LOAD: same as O440	506-1002-002
O442	Variable inductor gear train	GEAR, SPUR: plastic paper base; straight teeth; 120 teeth; straight face	506-1001-002
R401	Drive motor series resistor	RESISTOR, FIXED, WIREWOUND: 10 ohms ±5%, 8 w at 275° C	747-0062-00
S401	Control circuit switch	SWITCH SECTION, ROTARY: 2 pole, 12 position shorting type	269-1609-00
S402	Control circuit switch	SWITCH SECTION, ROTARY: 2 pole, 12 position shorting type	269-1608-00
	R-F VARIABLE CAPACITOR		542-6907-005
A501	Base plate	PLATE, BASE: aluminum, chromate dipped; 3/16 in. by 3 in. by 7-7/16 in.; 10 tapped 6-32 holes irregularly spaced for mtg	506-0943-003
A502	Gear plate	PLATE, GEAR: chromate dipped aluminum; 5/8 in. by 1-27/32 in. by 4-3/16 in.; five tapped 6-32 holes irregularly spaced for mtg	506-0946-004
A503		BASE, MOTOR: aluminum, two 0.136 in. dia holes spaced 0.687 in. c to c; mtd by three 0.147 in. dia holes irregularly spaced	506-0900-002
A504		PLATE, BEARING: chromate dipped aluminum; 0.090 in. by 0.936 in. by 1.436 in. three 0.147 in. dia mtg holes irregularly spaced	506-0917-002
A505		SUPPORT, YOKE: chromate dipped aluminum, 1/2 in. by 1-1/8 in. by 1.170 in.; mtd by two 6-32 NC-2B captive nuts spaced 0.750 in. c to c	506-0923-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
A506		PLATE, MOUNTING: chromate dipped aluminum; 0.090 in. by 21.124 in. by 2.436 in. mtd by three 0.187 in. dia holes on a 1.625 in. dia circle	506-0927-002
B501	R-f variable capacitor drive motor	MOTOR, D-C: permanent magnet type; 1/100 hp nominal output, no load speed 21,000 rpm; closed frame	230-0198-00
C501	R-f variable capacitor	CAPACITOR, VARIABLE: vacuum dielectric; single section, 7.0 to 970 uuf, copper anode	919-0136-00
E501	Variable capacitor insulator	INSULATOR, STANDOFF: round post shape; brass stud; 1-7/8 in. lg, 1/2 in. OD; #8-32 mtg end	506-4405-002
E502	Variable capacitor insulator	INSULATOR, STANDOFF: ceramic; 1/2 in. dia by 1.500 in. lg	190-0020-00
E503	Variable capacitor insulator	INSULATOR, STANDOFF: same as E502	190-0020-00
E504	Variable capacitor insulator	INSULATOR, STANDOFF: round post shape; brass stud; 1-7/8 in. lg; 1/2 in. OD; #8-32 mtg end	506-4405-002
E507	Transfer relay connector	TERMINAL, COUPLER: silver pl brass; 0.312 in. OD by 3/4 in. lg; mtd by 0.086 in. dia hole, 1/4 in. deep one end, 0.109 in. dia other end	506-0938-002
E507	Eff. MOD 1	CONTACT RELAY: brass, silver plated; cylindrical	541-5217-002
E508		TERMINAL, CLAMP, RING, SOLDERED: c/o copper braid shielding 0.3 ft, 1 ring terminal clamp and 1 resistor; brass; 9/32 in. by 1.876 in. by 2.173 in.; spring tension mtd; secured by two 0.120 in. dia holes	506-6568-002
E509	Eff. MOD 2	CONTACT, ELECTRICAL: coil silver contact point; 0.250 in. dia by 0.062 in. lg; 0.032 in. by 2.345 in. by 2.501 in. overall	542-6904-002
H501		STANDOFF: brass; 1/4 in. hex by 1 in. lg overall; ea end tapped 6-32 NC-2, 3/8 in. deep	500-0451-001
H502		SPACER, SLEEVE: brass; 0.159 in. ID, 0.255 in. OD, 0.375 in. lg overall	500-5013-001
H503		STANDOFF: alloy plated brass; 3/16 in. hex by 1.250 in. lg; ea end tapped 4-40 NC-2, 1/2 in. deep	500-6225-001
J501	Variable capacitor power connector	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 round female polarized contacts	371-0020-00
O502	Variable capacitor gear train	GEAR ASSEMBLY: soldered; incl one 18 tooth gear and one 50 tooth gear; bronze	506-0935-002
O503		POST, GEAR: passivated steel; 5/16 in. OD by 21/32 in. in. lg; mtd by 0.1887 in. dia, 0.171 in. lg one end	506-0904-002
O504	Variable capacitor gear train	GEAR ASSEMBLY: soldered; incl one 60 tooth and one 22 tooth gear; one gear bronze	506-0936-002
O505		POST, GEAR: passivated steel; 5/16 in. OD by 5/8 in. lg; mtd by one end 0.1887 in. dia, 0.171 in. lg	506-0907-002
O506	Variable capacitor gear train	GEAR ASSEMBLY: soldered; incl one 60 tooth gear and one 20 tooth gear, one gear bronze and one brass	506-0937-002
O507		POST, GEAR: passivated steel; 5/16 in. OD by 1/2 in. lg; mtd by 0.1887 in. dia, 0.171 in. lg	506-0910-002
O508	Variable capacitor gear train	GEAR ASSEMBLY: soldered; incl one 54 tooth gear and one 18 tooth gear; one gear brass, and one gear steel, type 303	506-0938-002
O509		GEAR, SECTOR: brass, 192 teeth, 20° pressure angle, 4.00 in. pitch dia, 0.095 in. by 29/32 in. by 2-5/32 in. approx	506-0914-002

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
O510	Variable capacitor gear train	GEAR, SPUR: 192 teeth gear; brass gear; straight teeth; straight face; shaft mtd	506-0933-002
O511		BEARING, SLEEVE: porous bronze; 0.439 in. max ID, 0.564 in. max OD, 0.184 in. max lg overall; 11/16 in. max OD by 0.048 in. max w flange	506-0915-002
O512		BEARING, SLEEVE: porous bronze; 0.189 in. max ID, 0.3145 in. max OD, 0.140 in. max lg overall; 7/16 in. max OD by 0.031 in. max w flange	506-0916-002
O513		SHAFT, YOKE: passivate steel; 0.186 in. OD by 29/32 in. lg; thru hole mtg	506-0919-002
O514		BAR, YOKE: p/o vacuum capacitor; c/o 1 yoke, 1 stud, wire; 0.156 in. by 1-1/2 in. by 3-1/16 in.; 6-32 thd for mtg	506-0932-002
R501	Drive motor series resistor	RESISTOR, FIXED, WIREWOUND: 5.0 ohms ±5%, 8 w at 275° C	747-0059-00
R502		DELETED	
R503	Static drain resistor Eff. MOD 1	RESISTOR, FIXED: screw mtd; high voltage; 8.2 megohms ±20%, 4 w	731-0036-00
S501	Control circuit switch	SWITCH, SENSITIVE: dpst; normally closed; 1 amp, 28 v d-c, resistive load	269-1607-00
S502	Control circuit switch	SWITCH, SENSITIVE: 3 dpst; 2 circuits normally closed, 1 circuit normally open; 1 amp, 28 v d-c resistive load	269-1605-00
	SERVO AMPLIFIER		506-0899-004
A601		CHASSIS, SERVO AMPLIFIER: chromate dipped aluminum; 1-1/8 in. by 4-3/16 in. by 4-7/8 in. four tapped 4-40 NC-2 mtg holes irregularly spaced	506-0898-004
A601		BRACKET, MOUNTING: steel; 11/32 in. by 1/2 in. by 0.515 in.; two 0.093 in. dia mtg holes spaced 0.250 in. c to c	506-0888-002
A602		BRACKET, MOUNTING: same as A601	506-0888-002
B601		MOTOR, A-C: squirrel-cage induction type, 18 v, 400 cps, two phase; 3000 rpm, single take-off shaft, cw	230-0107-00
B601	Phase sensitive relay motor	MOTOR, A-C: wound rotor induction; 18 v a-c, 400 cps, double phase; 3000 rpm full load rating, single take-off shaft, cw	506-0892-002
C601	Loading lead network	CAPACITOR, FIXED, PAPER: 470,000 uuf ±20%, 100 vdcw	931-0408-00
C604	1st loading amplifier coupling	CAPACITOR, FIXED, PAPER: 10,000 uuf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0349-00
	Eff. MOD 1	CAPACITOR, FIXED, PAPER: 100,000 uuf ±20%, 100 vdcw	931-2503-00
C605	1st - 2nd loading amplifier coupling	CAPACITOR, FIXED, PAPER: 0.01 uf ±20%, 400 vdcw	931-2529-00
C606	2nd - 3rd loading amplifier	CAPACITOR, FIXED, PAPER: same as C605	931-2529-00
C607	Loading balance	CAPACITOR, FIXED, PAPER: 0.0033 uf ±10%, 150 vdcw at 125° C, 200 vdcw at 85° C	931-0343-00
C608	Loading decoupling	CAPACITOR, FIXED, PAPER: 470,000 uuf ±20%, 300 vdcw	931-0630-00
C610	Phasing audio filter	CAPACITOR, FIXED, PAPER: 1500 uuf ±20%, 100 vdcw	931-0393-00

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
	C611	Phasing lead network	CAPACITOR, FIXED, PAPER: 0.01 uf ±20%, 100 vdcw	931-0404-00
	C612	1st phasing amplifier coupling	CAPACITOR, FIXED, PAPER: 0.047 uf ±10%, 150 vdcw at 125° C, 200 vdcw at 85° C	931-0329-00
	C613	1st - 2nd phasing amplifier coupling	CAPACITOR, FIXED, PAPER: same as C605	931-2529-00
	C614	2nd - 3rd phasing amplifier coupling	CAPACITOR, FIXED, PAPER: same as C605	931-2529-00
	C616	Phasing output transformer tuning	CAPACITOR, FIXED, PAPER: 100,000 uuf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0333-00
		Eff. MOD 1	CAPACITOR, FIXED, PAPER: 0.068 uf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0331-00
	C617	Phasing decoupling	CAPACITOR, FIXED, PAPER: same as C608	931-0630-00
	C620	R-f filter	CAPACITOR, FIXED, MICA: 470 uuf ±10%, 300 vdcw	912-0543-00
	C622	R-f filter	CAPACITOR, FIXED, MICA: same as C620	912-0543-00
	C623	Filter	CAPACITOR, FIXED, PAPER: 10,000 uuf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0349-00
	C624	Eff. MOD 4	CAPACITOR, FIXED, PAPER: 10,000 uuf ±10%, 150 vdcw at 125° C and 200 vdcw at 85° C	931-0349-00
R	C626	Eff. MOD 7	CAPACITOR, FIXED, PAPER: 0.068 uf ±20%, 200 v d-c; Cornell-Dubilier Electric Corp. part no. TWU2S68-4P	931-2542-00
R	C627	Eff. MOD 7	CAPACITOR, FIXED, PAPER: same as C626	931-2542-00
R	CR601	Eff. MOD 7	NOT USED	
R	CR602	Eff. MOD 7	NOT USED	
	E601		SHIELD, ELECTRON TUBE: accommodates T-6-1/2 tube; 1.065 in. dia, 1.9375 in. lg	141-0147-00
	E602		SHIELD, ELECTRON TUBE: same as E601	141-0147-00
	E603		SHIELD, ELECTRON TUBE: same as E601	141-0147-00
		Eff. serial no. 180L-2, 2855; 180L-3, 5628; 180L-3A, 191	SHIELD, ELECTRON TUBE: 9 pin medium; cylindrical w/ flared end; open top; brass; 0.95 in. by 1.065 in.; incl beryllium copper insert	541-6554-003
			SHIELD, ELECTRON TUBE: same as E601	141-0147-00
			SHIELD, ELECTRON TUBE: same as E601	141-0147-00
	E604		SHIELD, SERVO: chromate dipped aluminum; 1.064 in. by 4.283 in. by 4.907 in.; four 0.152 in. dia holes	506-1167-003
	E605		TERMINAL, STUD: brass conductor; 1/4 in. hex by 9/16 in. lg overall	306-0091-00
	E606		TERMINAL, STUD: same as E605	306-0091-00
	E607 thru E610		TERMINAL, STUD: brass conductor; 1/4 in. hex by 0.788 in. lg	306-0233-00
	E611	Resistor mounting	POST, SUPPORTING: aluminum chromate dipped; 1-3/32 in. lg by 1/4 in. dia overall; 2 top mtg holes 4-40 NC-2 by 3/8 in. on each end	503-0970-001
	E612	Eff. MOD 3	TERMINAL, STUD: same as E605	306-0091-00
	E613	Eff. MOD 3	TERMINAL, STUD: same as E605	306-0091-00
R	E614	Eff. MOD 5	TERMINAL, STUD: brass base, silver plated brass terminal; insulated; 1/4 in. w across flats by 25/32 in. lg o/a; Whitso Inc. part no. 2B1-DB12	306-0233-00
	G601	Loading and phasing chopper	VIBRATOR, SYNCHRONOUS: input 6.3 v rms ±7%, reed freq. 400 cps ±20% cps	354-1014-00
	H601		SCREW, EXTERNALLY RELIEVED BODY: stainless steel; panhead; 6-32 NC-2A thd, 0.156 in. lg; 7/16 in. lg overall	506-0887-002

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
	J601	Servo power connector	CONNECTOR, RECEPTACLE, ELECTRICAL: 15 round female polarized contacts	371-0020-00
	L601	Eff. MOD	COIL, RADIO FREQUENCY: single wound; 3 layers; unshielded; 7.5 mh ±10% at 7.9 mc; 71 turns #28 AWG copper wire	240-0098-00
	O601		LUG, ACTIVATOR: plastic; 0.281 in. dia by 5/16 in. lg; one 0.175 in. dia mtg hole 0.187 in. deep	506-0889-002
	O602		CLAMP, CHOPPER: steel; 1/2 in. lg, 5/8 in. by 1.133 in.; one hole tapped 6-40 NF-2B for mtg	540-2875-002
	R601	Loading lead network	RESISTOR, FIXED, COMPOSITION: 0.10 megohm ±10%, 1/2 w	745-1436-00
	R602	Loading lead network	RESISTOR, FIXED, COMPOSITION: 0.33 megohm ±10%, 1/2 w	745-1457-00
	R604	1st loading amplifier grid	RESISTOR, FIXED, COMPOSITION: 0.47 megohm ±10%, 1/2 w	745-1464-00
	R606	1st loading amplifier plate	RESISTOR, FIXED, COMPOSITION: 0.22 megohm ±10%, 1/2 w	745-1450-00
	R607	2nd loading amplifier grid	RESISTOR, FIXED, COMPOSITION: same as R604	745-1464-00
	R609	2nd loading amplifier plate	RESISTOR, FIXED, COMPOSITION: 0.22 megohm ±10%, 1 w	745-3450-00
	R610	3rd loading amplifier grid	RESISTOR, FIXED, COMPOSITION: same as R606	745-1450-00
	R611	Phasing lead network	RESISTOR, FIXED, COMPOSITION: same as R601	745-1436-00
R	R612	Eff. MOD 6 Phasing lead network	RESISTOR, FIXED, COMPOSITION: same as R604	745-1464-00
R	R614	Eff. MOD 6	RESISTOR, FIXED, COMPOSITION: 68,000 ohms ±10%, 1/2 w; MIL type RC20GF683K	745-1429-00
	R616	1st phasing amplifier plate	RESISTOR, FIXED, COMPOSITION: same as R606	745-1450-00
	R617	2nd phasing amplifier grid	RESISTOR, FIXED, COMPOSITION: same as R604	745-1464-00
	R619	2nd phasing amplifier plate	RESISTOR, FIXED, COMPOSITION: same as R609	745-3450-00
	R620	3rd phasing amplifier plate	RESISTOR, FIXED, COMPOSITION: same as R604	745-1464-00
	R621	3rd phasing amplifier cathode	RESISTOR, FIXED, COMPOSITION: 1000 ohms ±10%, 1/2 w	745-1352-00
	R622	Loading decoupling	RESISTOR, FIXED, COMPOSITION: same as R606	745-1450-00
	R623	Phasing decoupling	RESISTOR, FIXED, COMPOSITION: same as R606	745-1450-00
	R624		RESISTOR, FIXED, WIREWOUND: 71 ohms ±5%, 8 w	747-0111-00
	R624	Eff. MOD 3	NOT USED	
	R625	R-f filter	RESISTOR, FIXED, COMPOSITION: 27,000 ohms ±10%, 1/2 w	745-1412-00
	R626	R-f filter	RESISTOR, FIXED, COMPOSITION: same as R625	745-1412-00
R	*R629		RESISTOR, FIXED, COMPOSITION: 15,000 ohms ±10%, 1/2 w; MIL type RC20GF153K	745-1401-00
	*R629		RESISTOR, FIXED, COMPOSITION: 18,000 ohms ±10%, 1/2 w; MIL type RC20GF183K	745-1405-00
	*R629		RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%, 1/2 w; MIL type RC20GF223K	745-1408-00
	*R629		RESISTOR, FIXED, COMPOSITION: 27,000 ohms ±10%, 1/2 w; MIL type RC20GF273K	745-1412-00

*Selected in test

	ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
	*R629		RESISTOR, FIXED, COMPOSITION: 33,000 ohms ±10%, 1/2 w; MIL type RC20GF333K	745-1415-00
	*R629		RESISTOR, FIXED, COMPOSITION: 39,000 ohms ±10%, 1/2 w; MIL type RC20GF393K	745-1419-00
	*R629		RESISTOR, FIXED, COMPOSITION: 47,000 ohms ±10%, 1/2 w; MIL type RC20GF473K	745-1422-00
	*R629		RESISTOR, FIXED, COMPOSITION: 56,000 ohms ±10%, 1/2 w; MIL type RC20GF563K	745-1426-00
	*R629		RESISTOR, FIXED, COMPOSITION: 68,000 ohms ±10%, 1/2 w; MIL type RC20GF683K	745-1429-00
	*R629		RESISTOR, FIXED, COMPOSITION: 82,000 ohms ±10%, 1/2 w; MIL type RC20GF823K	745-1433-00
	R630	Bias voltage divider	RESISTOR, FIXED, COMPOSITION: 1000 ohms ±5%, 1 w	745-3351-00
	R631	Bias voltage divider	RESISTOR, FIXED, COMPOSITION: 100 ohms ±5%, 1/2 w	745-1309-00
	R632	Desensitizing voltage divider	RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%, 1/2 w	745-1408-00
		Eff. MOD 4	RESISTOR, FIXED, COMPOSITION: 220,000 ohms ±10%, 1/2 w	745-1450-00
	R633	Desensitizing voltage divider	RESISTOR, FIXED, COMPOSITION: 18,000 ohms ±10%, 1/2 w	745-1405-00
		Eff. MOD 4	RESISTOR, FIXED, COMPOSITION: 180,000 ohms ±10%, 1/2 w	745-1447-00
	R634	Eff. MOD 3	RESISTOR, FIXED, WIREWOUND: 25 ohms ±5%, 8 w	747-0066-00
R	R635	Eff. MOD 6	NOT USED	
	R636	Eff. MOD 4	RESISTOR, FIXED, COMPOSITION: 100,000 ohms ±10%, 1/2 w	745-1436-00
R	R638	Eff. MOD 7	RESISTOR, FIXED, COMPOSITION: 100 ohms ±10%, 1/2 w; MIL type RC20GF101K	745-1310-00
	S601	Phase sensitive relay switch	SWITCH, SENSITIVE: single pole, 3 position normally open; 0.5 amp, 28 v dc, resistive load	269-1604-00
	T601	Chopper coil transformer	TRANSFORMER, POWER: fil type; input 115 v 360/440 cps; 1 output wound 6.3 ±0.2 v CT at 0.25 amp; 700 v test	672-0463-00
	T602	Phasing output transformer	TRANSFORMER, POWER: same as T601	672-0463-00
		Eff. MOD 1	TRANSFORMER, AUDIO FREQUENCY: plate coupling type; 20,000 ohms primary, secondary 150 ohms, 400 cps frequency	677-0626-00
	TB601	Servo terminal board	TERMINAL BOARD: general purpose; 16 brass silver plated terminals; irregularly spaced; plastic laminated board	506-0896-003
	V601	1st loading amplifier, 1st phasing amplifier	ELECTRON TUBE: type 5751; double triode	253-0012-00
	V602	2nd loading amplifier, 2nd phasing amplifier	ELECTRON TUBE: same as V601	253-0012-00
	V603	3rd loading amplifier, 3rd phasing amplifier	ELECTRON TUBE: type 5814; double triode	253-0013-00
	XG601	G601 socket	TUBE SOCKET: 7 contact miniature	220-1044-00
	XV601	V601 socket	TUBE SOCKET: 9 pin miniature	220-1103-00
	XV602	V602 socket	TUBE SOCKET: 9 pin miniature	220-1103-00
	XV603	V603 socket	TUBE SOCKET: 9 pin miniature	220-1103-00

*Selected in test

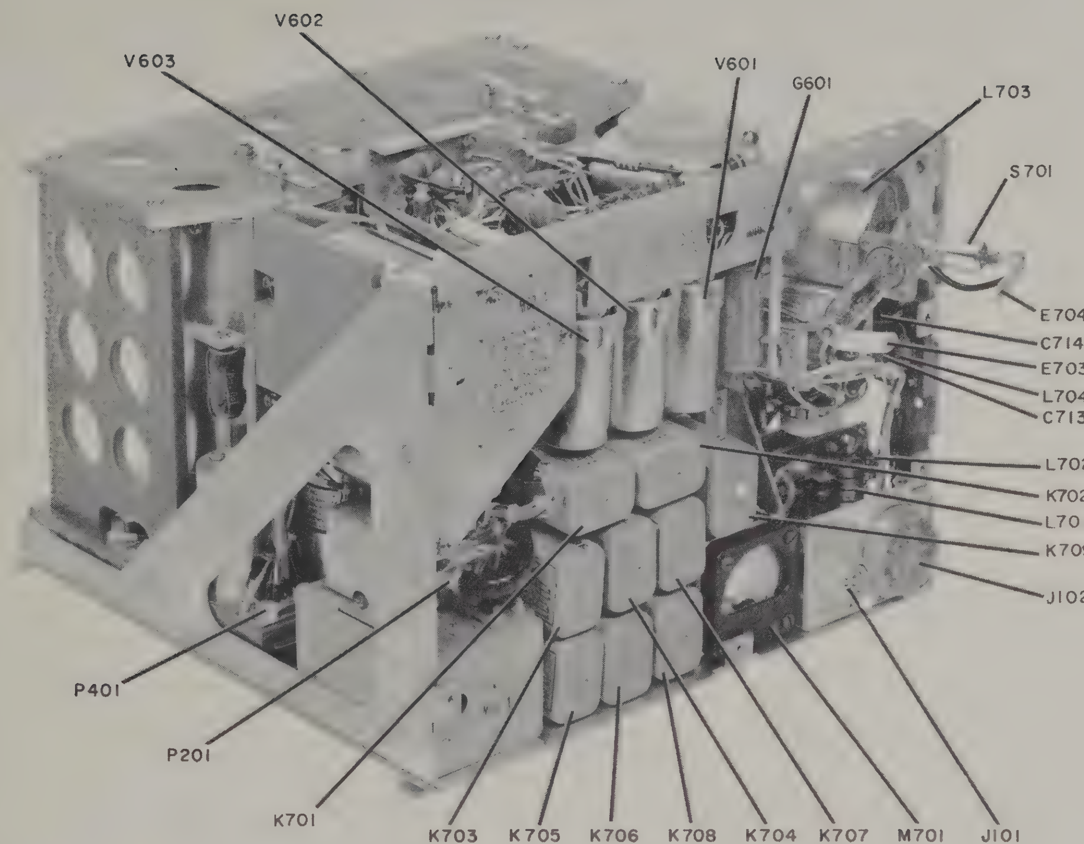


Figure 6-1. Automatic Antenna Tuner 180L-3, Front View, Covers Removed

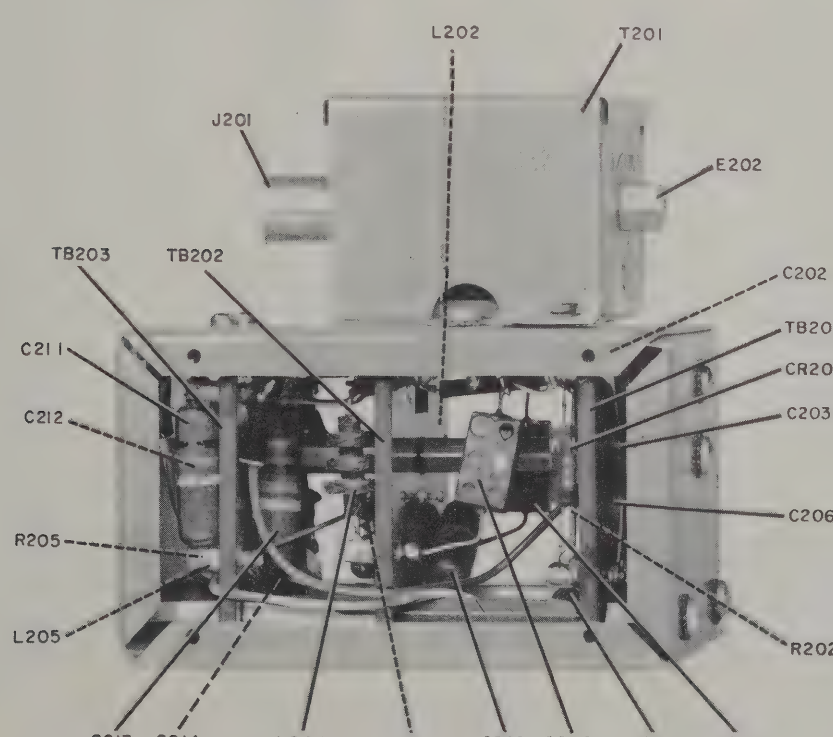


Figure 6-2. Discriminator Subassembly, Right Side View, Covers Removed

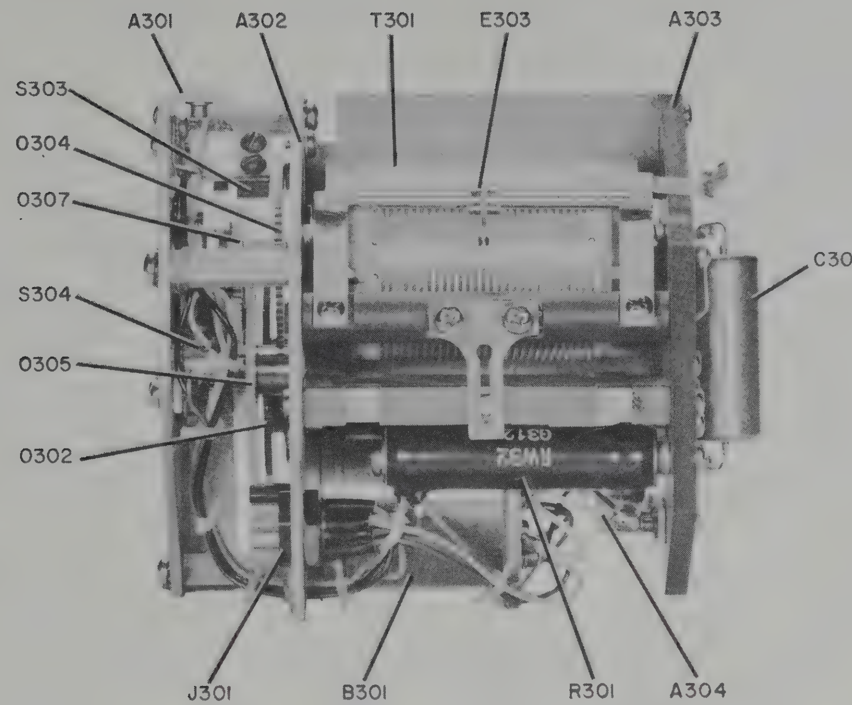


Figure 6-3. R-F Autotransformer Subassembly, Right Side View

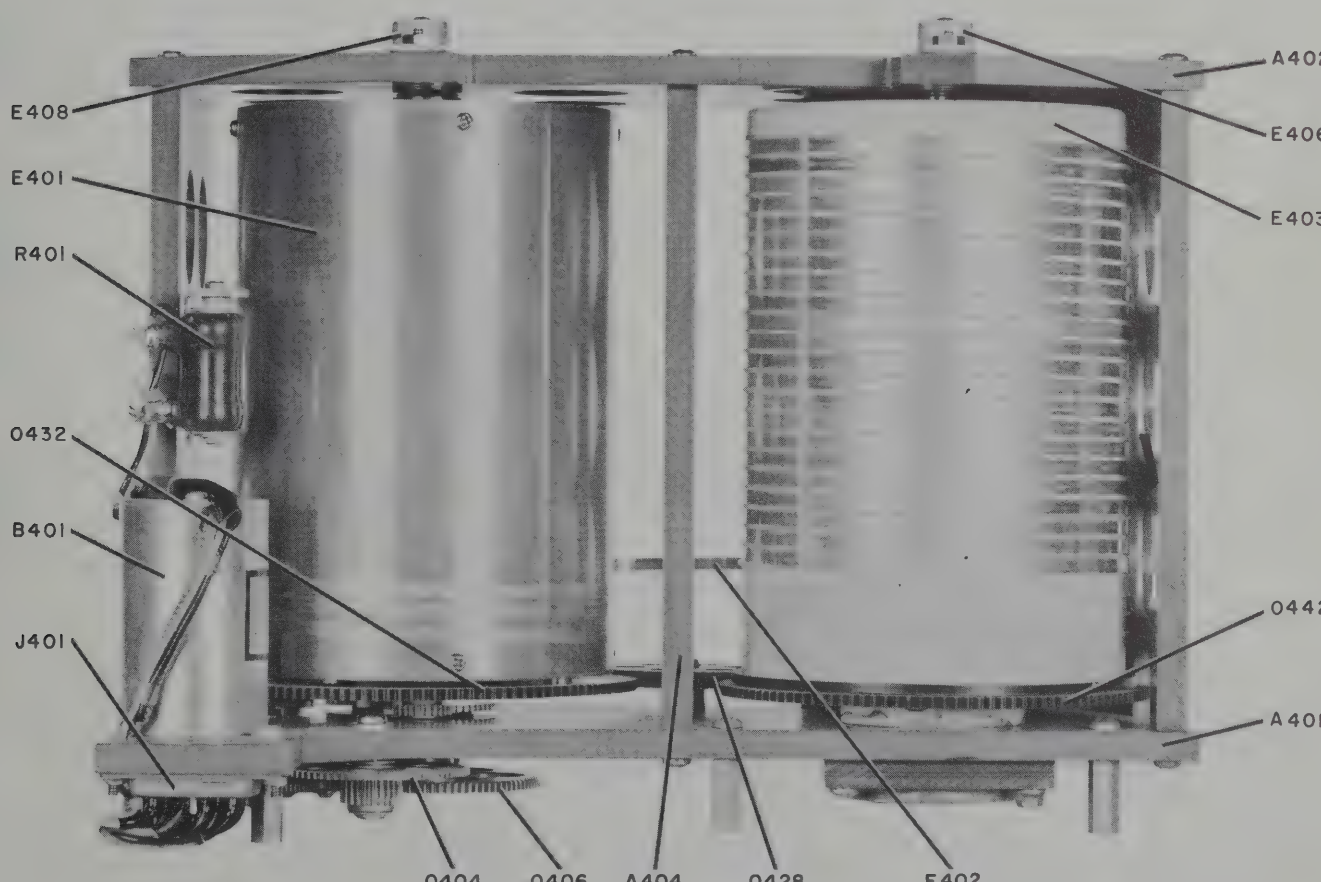


Figure 6-4. Variable Inductor Subassembly, Front View

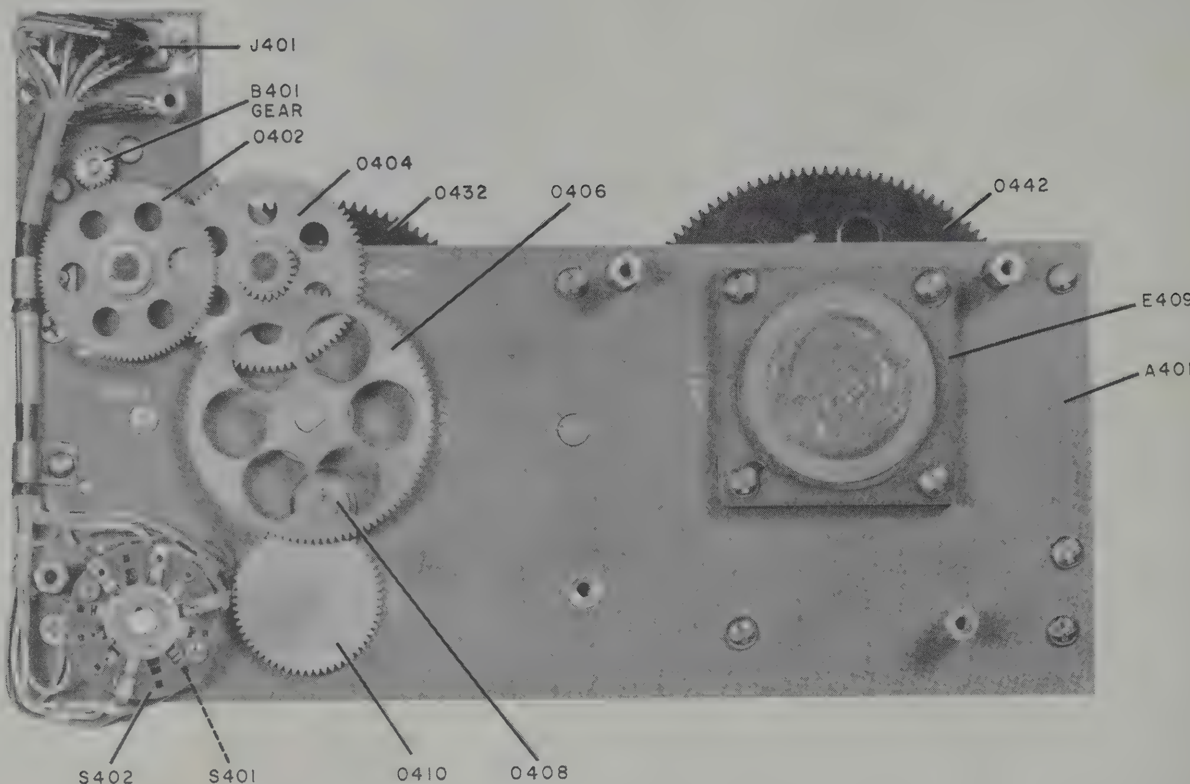


Figure 6-5. Variable Inductor Subassembly, Bottom View

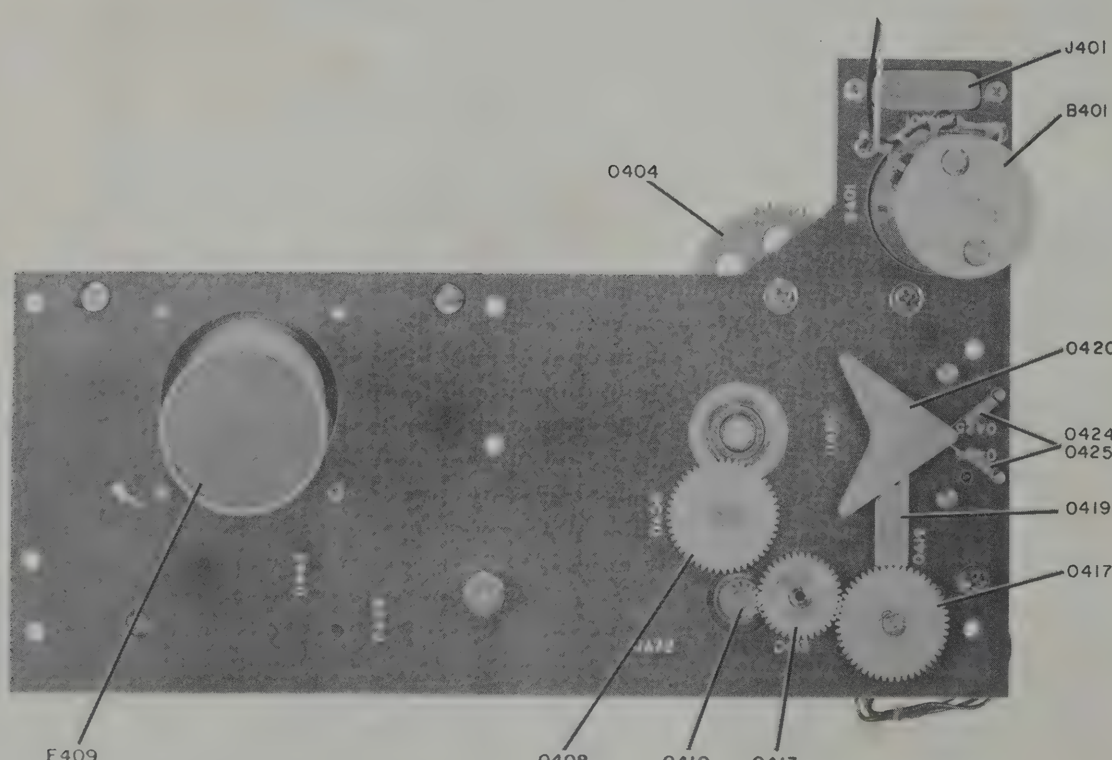


Figure 6-6. Variable Inductor Subassembly, Top View with Drums Removed

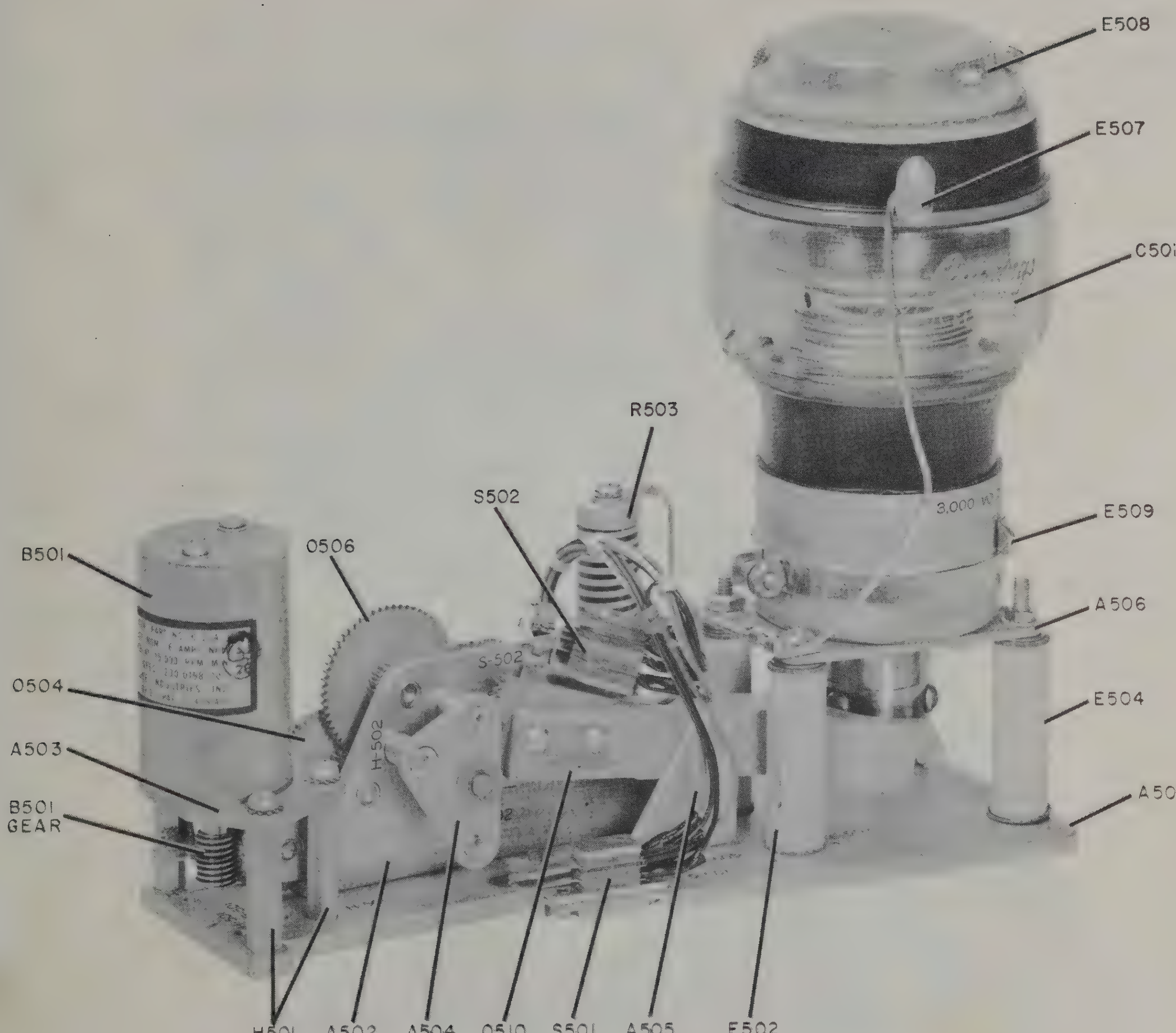


Figure 6-7. Variable Capacitor Subassembly, Front View

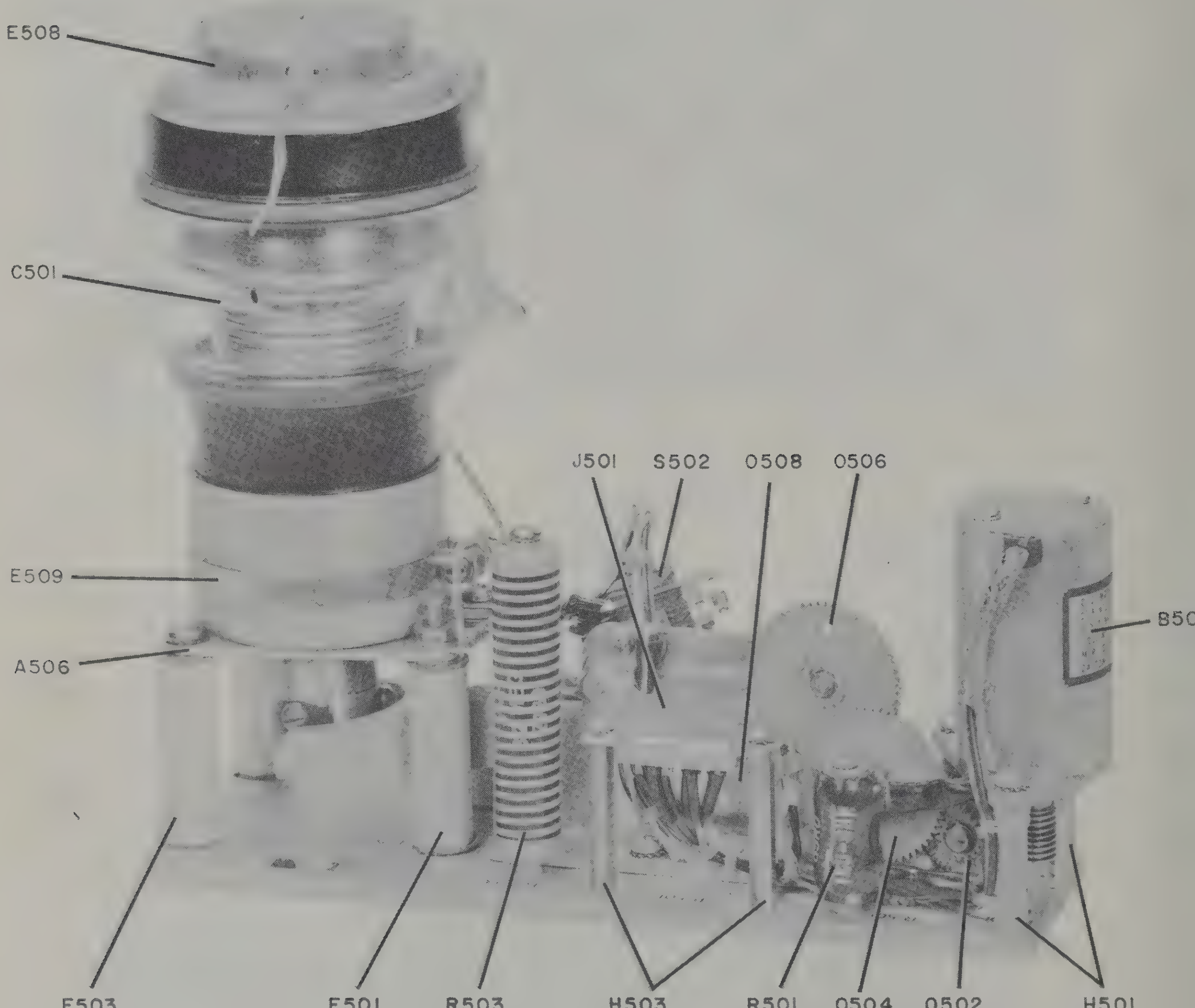


Figure 6-8. Variable Capacitor Subassembly, Rear View

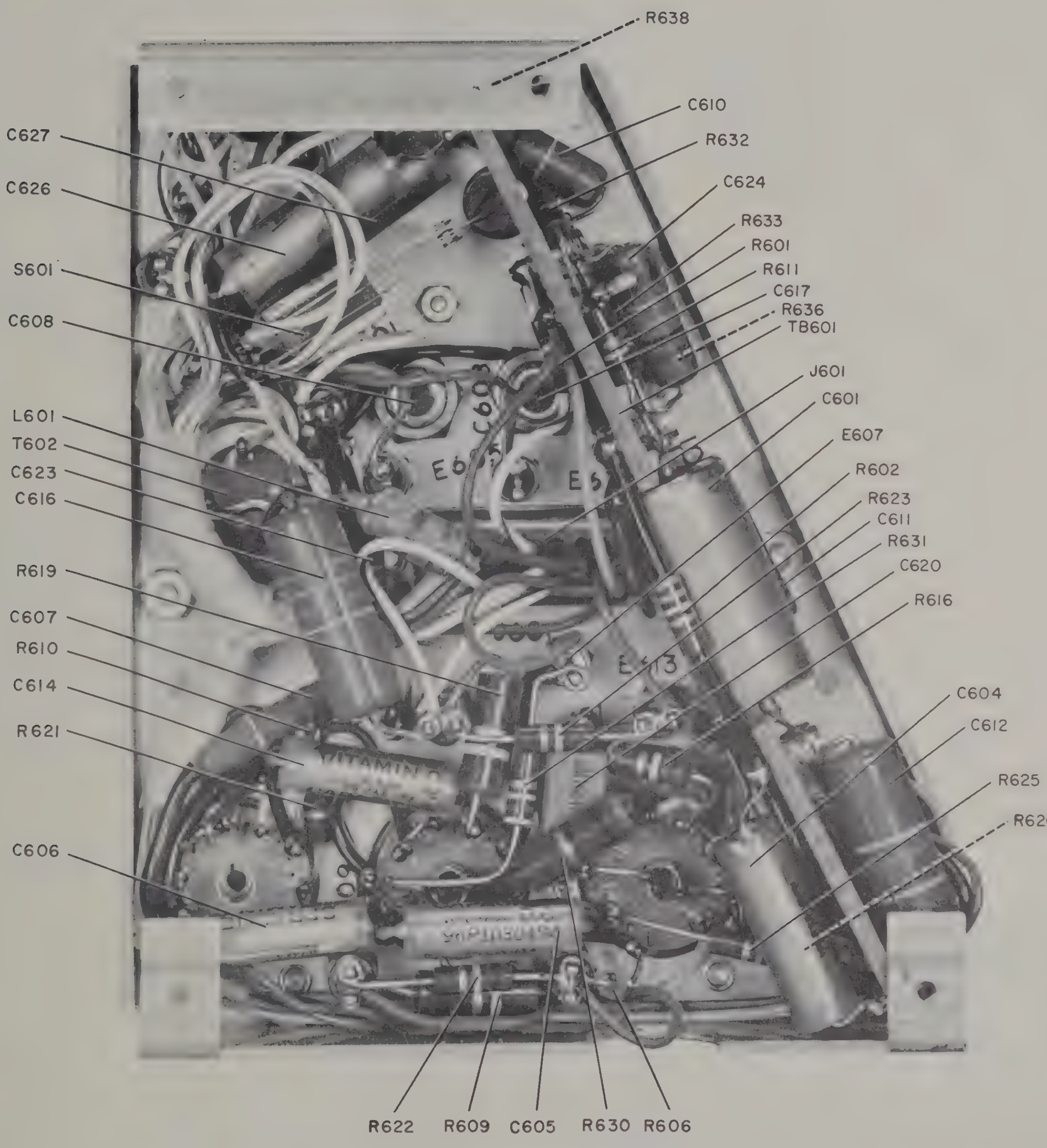
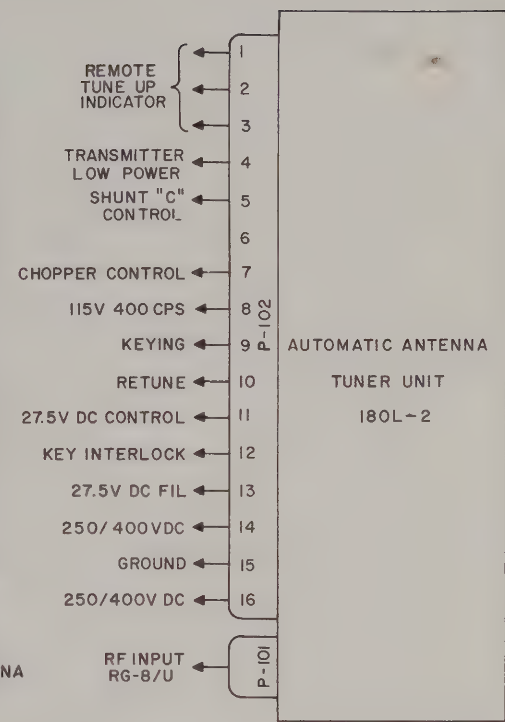


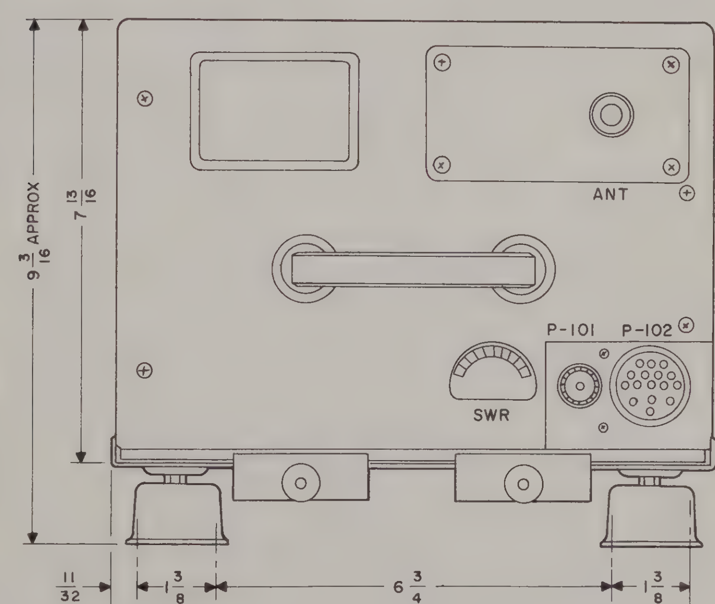
Figure 6-9. Servo-Amplifier Subassembly, Top View, Cover Removed

SECTION VII
ILLUSTRATIONS

P-102		
IN NO	VOLTAGE	MAX CURRENT (AMPERES)
1	27.5	2.0*
2	27.5	2.0*
3	27.5	2.0*
4		**
5	27.5	0.15
6		
7	115	0.15
8	115	0.15
9	27.5	0.2**
0	27.5	0.15
1	27.5	1.5**
2	27.5	**
3	27.5	1.0**
4	250/400	0.035
5	0	2.5
6	250/400	0.035

* MAX RELAY CONTACT CURRENT RATING.
ADDITIONAL CURRENT DRAINS DEPEND UPON TRANSMITTER USED.
MIN CLEARANCE FOR VOLTAGE BREAKDOWN TO ALL METAL PARTS. SIMILAR CLEARANCE REQUIRED FOR ANTENNA LEAD-IN WIRE.





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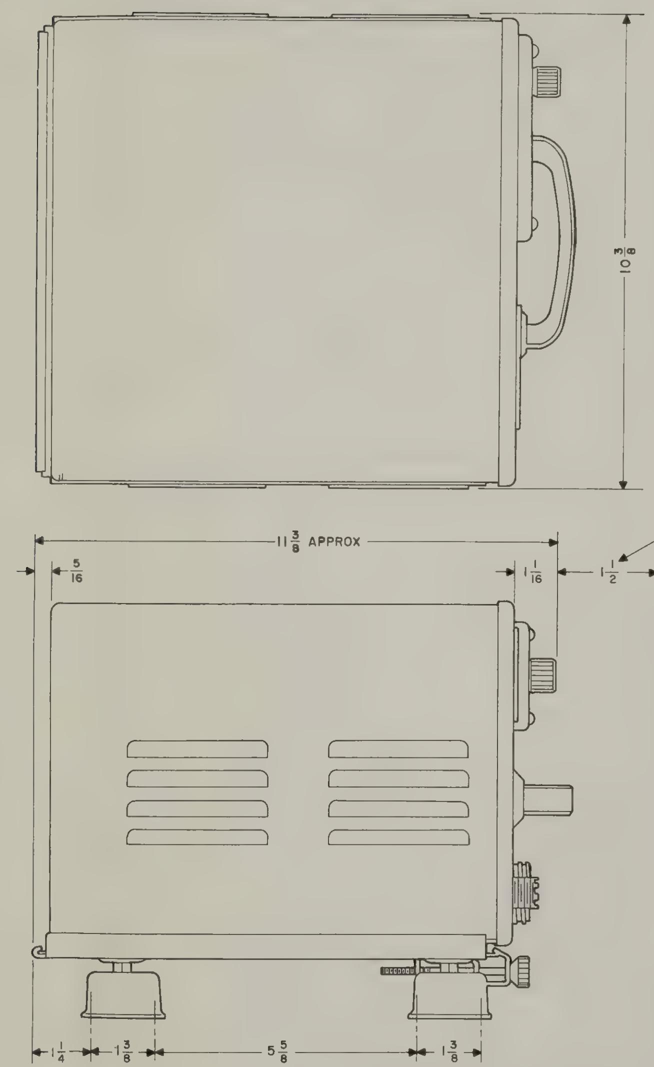
REMOVAL

Figure 7-1. Automatic Antenna Tuner 180L-2, Outline and Mounting Dimensions

SECTION VII
ILLUSTRATIONS

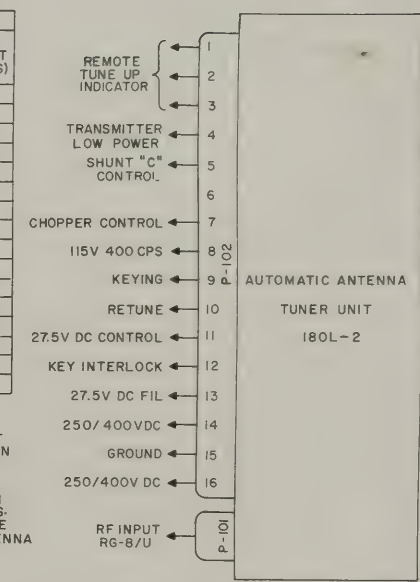


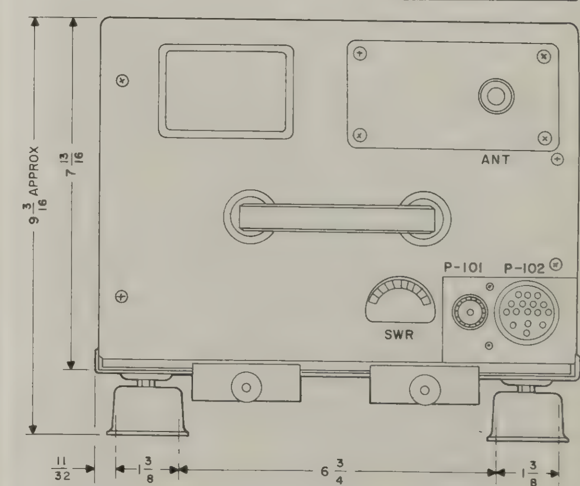
P-102		
PIN NO	VOLTAGE	MAX CURRENT (AMPERES)
1	27.5	2.0*
2	27.5	2.0*
3	27.5	2.0*
4		**
5	27.5	0.15
6		
7	115	0.15
8	115	0.15
9	27.5	0.2**
10	27.5	0.15
11	27.5	1.5**
12	27.5	**
13	27.5	1.0**
14	250/400	0.035
15	0	2.5
16	250/400	0.035

* MAX RELAY CONTACT CURRENT RATING.

** ADDITIONAL CURRENT DRAINS DEPEND UPON TRANSMITTER USED.

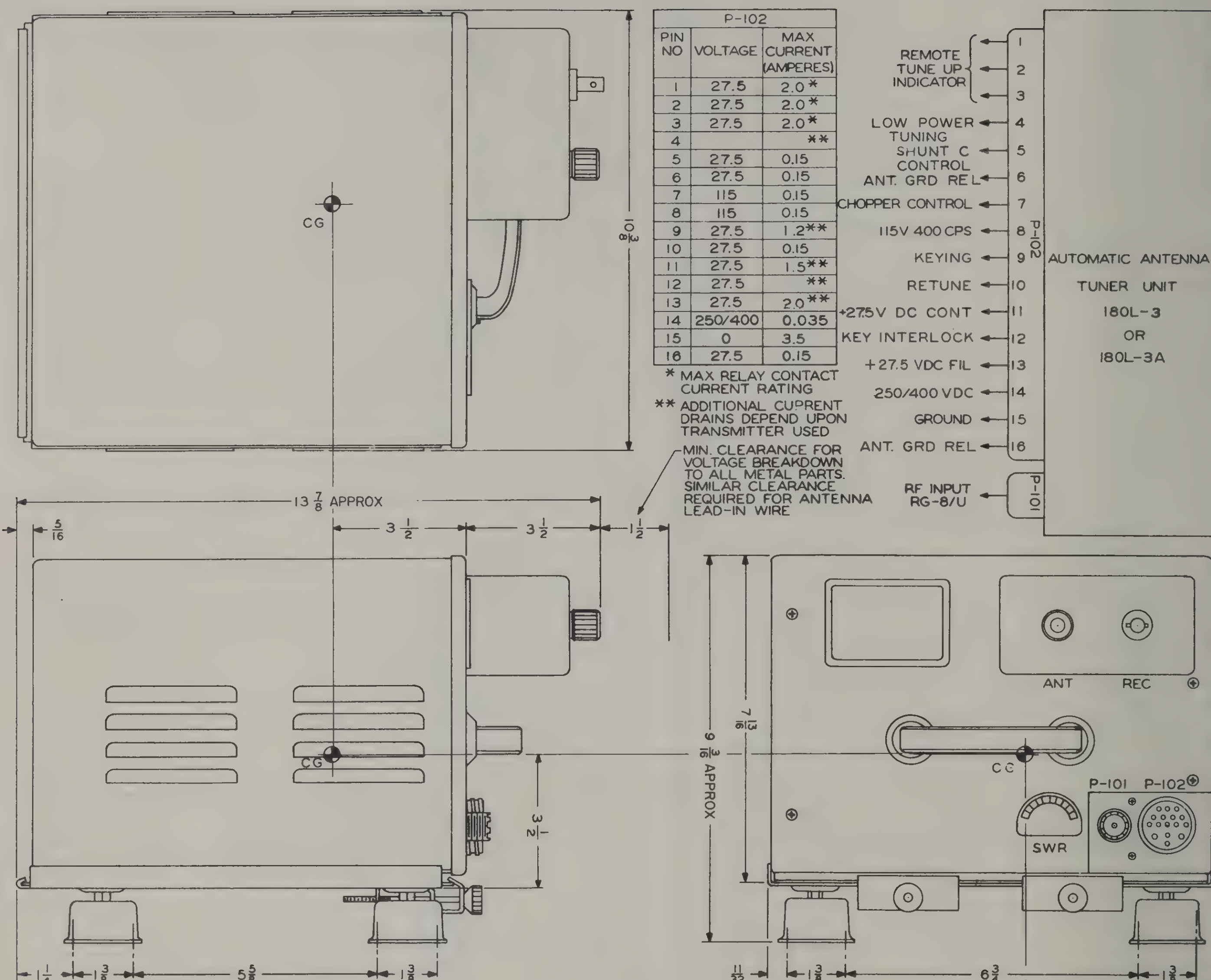
MIN CLEARANCE FOR VOLTAGE BREAKDOWN TO ALL METAL PARTS. SIMILAR CLEARANCE REQUIRED FOR ANTENNA LEAD-IN WIRE.





NOTES:
1. APPROXIMATE WEIGHT 20 LBS.
2. 16 MTG HOLES .196 DIA.
3. ALL DIMENSIONS ARE IN INCHES.
4. CLEARANCE OF 1/2 INCH REQUIRED ON ALL SIDES AND TOP FOR FREE MOVEMENT OF UNIT ON SHOCKMOUNT.
5. SPOT FACE 4 OF 16 MOUNTING HOLES FOR CONTACT WITH GROUNDING STRIPS.
6. 6 INCH CLEARANCE REQUIRED AT FRONT FOR REMOVAL OF CONNECTOR AND FRONT PANEL.

Figure 7-1. Automatic Antenna Tuner 180L-2. Outline and Mounting Dimensions



P-102		
PIN NO	VOLTAGE	MAX CURRENT (AMPERES)
1	27.5	2.0 *
2	27.5	2.0 *
3	27.5	2.0 *
4		**
5	27.5	0.15
6	27.5	0.15
7	115	0.15
8	115	0.15
9	27.5	1.2 **
10	27.5	0.15
11	27.5	1.5 **
12	27.5	**
13	27.5	2.0 **
14	250/400	0.035
15	0	3.5
16	27.5	0.15

* MAX RELAY CONTACT CURRENT RATING
** ADDITIONAL CURRENT DRAINS DEPEND UPON TRANSMITTER USED

NOTES:
1. APPROXIMATE WEIGHT 21 LBS
2. 16 MTG HOLES .196 DIA
3. ALL DIMENSIONS ARE IN INCHES
4. CLEARANCE OF ½ INCH REQUIRED ON ALL SIDES AND TOP FOR FREE MOVEMENT OF UNIT ON SHOCKMOUNT
5. SPOT FACE 4 OF 16 MOUNTING HOLES FOR CONTACT WITH GROUNDING STRIPS
6. 8 INCH CLEARANCE REQUIRED AT FRONT FOR REMOVAL OF CONNECTOR AND FRONT PANEL
7. PINS 6 AND 16 OF P-102 ARE USED ONLY ON 180L-3A

Figure 7-2. Automatic Antenna Tuner 180L-3 or 180L-3A, Outline and Mounting Dimensions

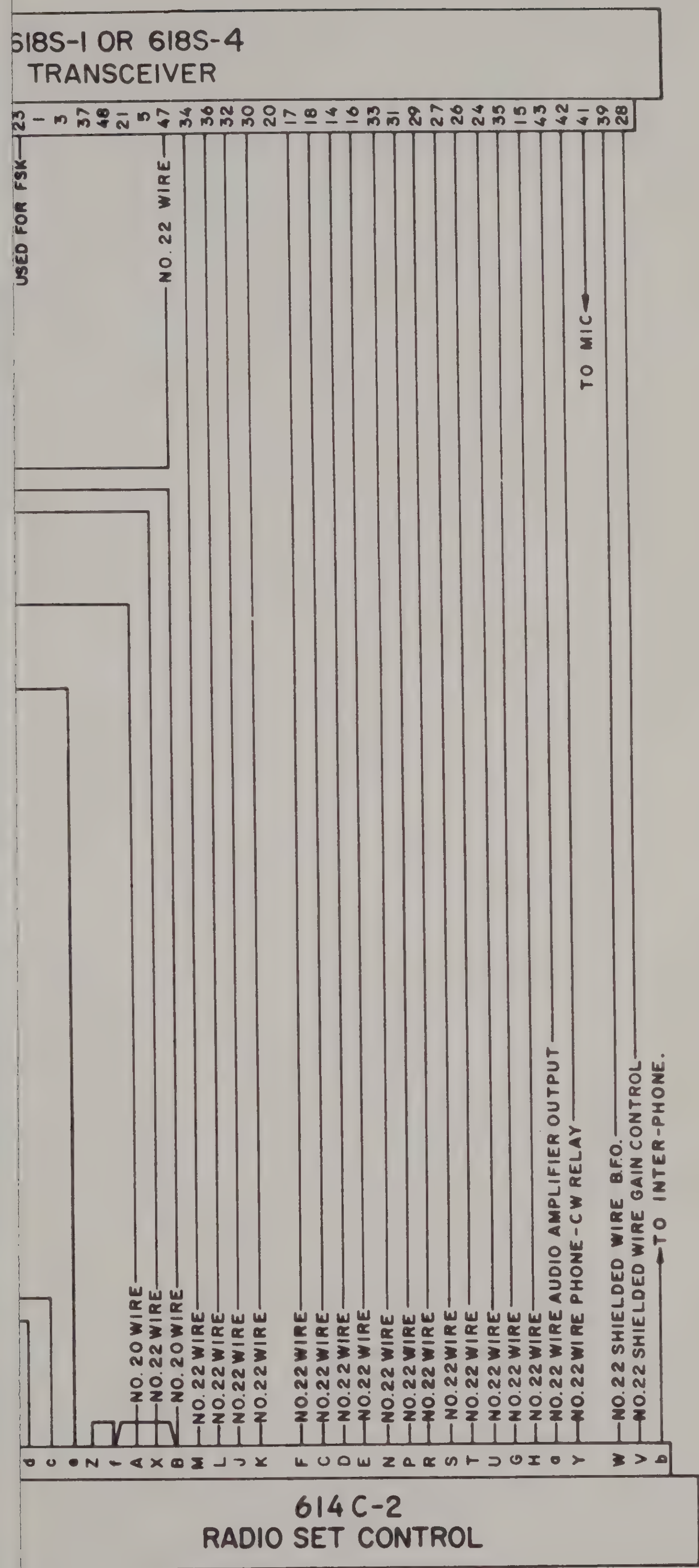
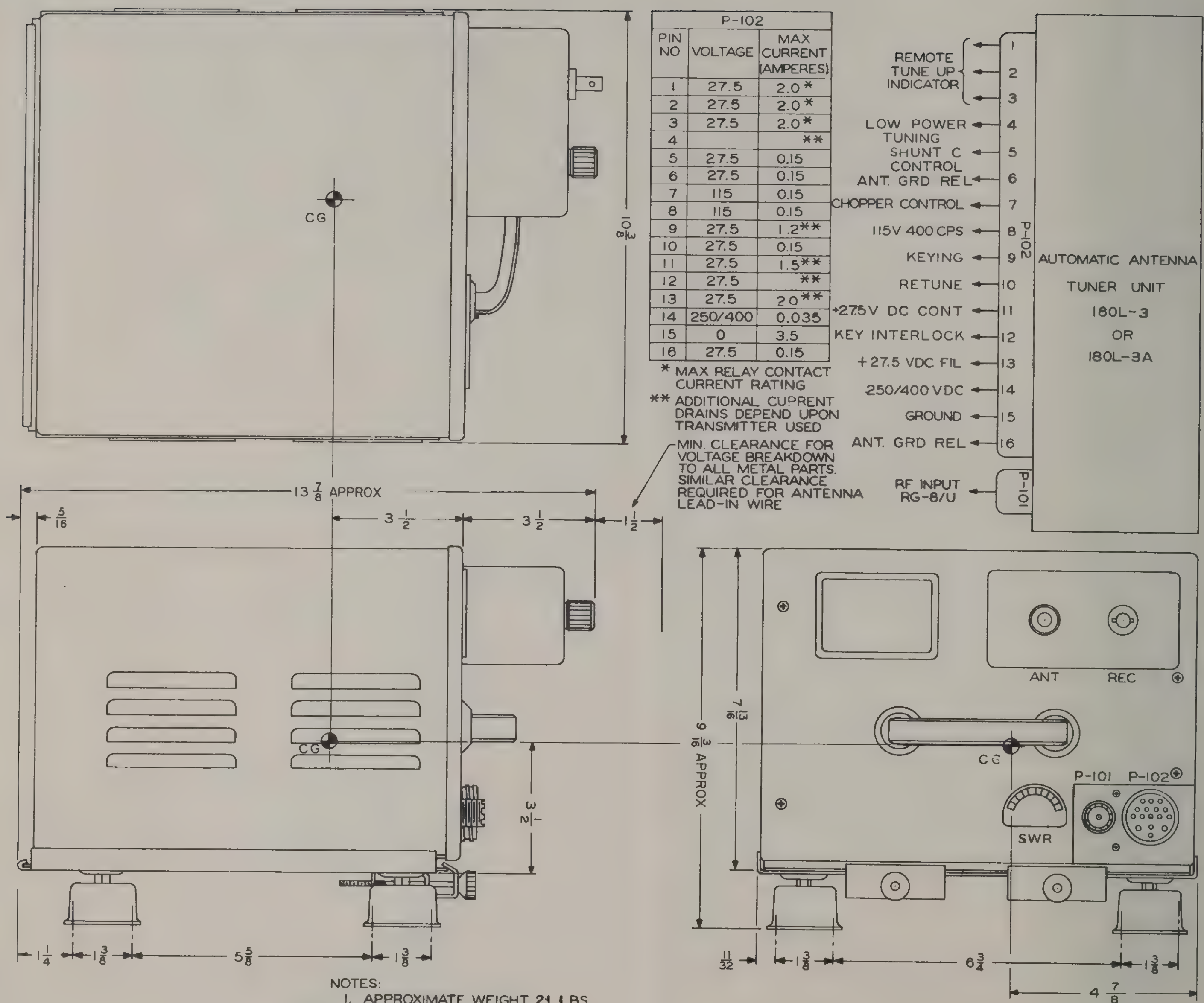


Figure 7-3. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, External Wiring Diagram Using Transceiver 618S-1 or 618S-4



P-102		
PIN NO	VOLTAGE	MAX CURRENT (AMPERES)
1	27.5	2.0 *
2	27.5	2.0 *
3	27.5	2.0 *
4		**
5	27.5	0.15
6	27.5	0.15
7	115	0.15
8	115	0.15
9	27.5	1.2 **
10	27.5	0.15
11	27.5	1.5 **
12	27.5	**
13	27.5	2.0 **
14	250/400	0.035
15	0	3.5
16	27.5	0.15

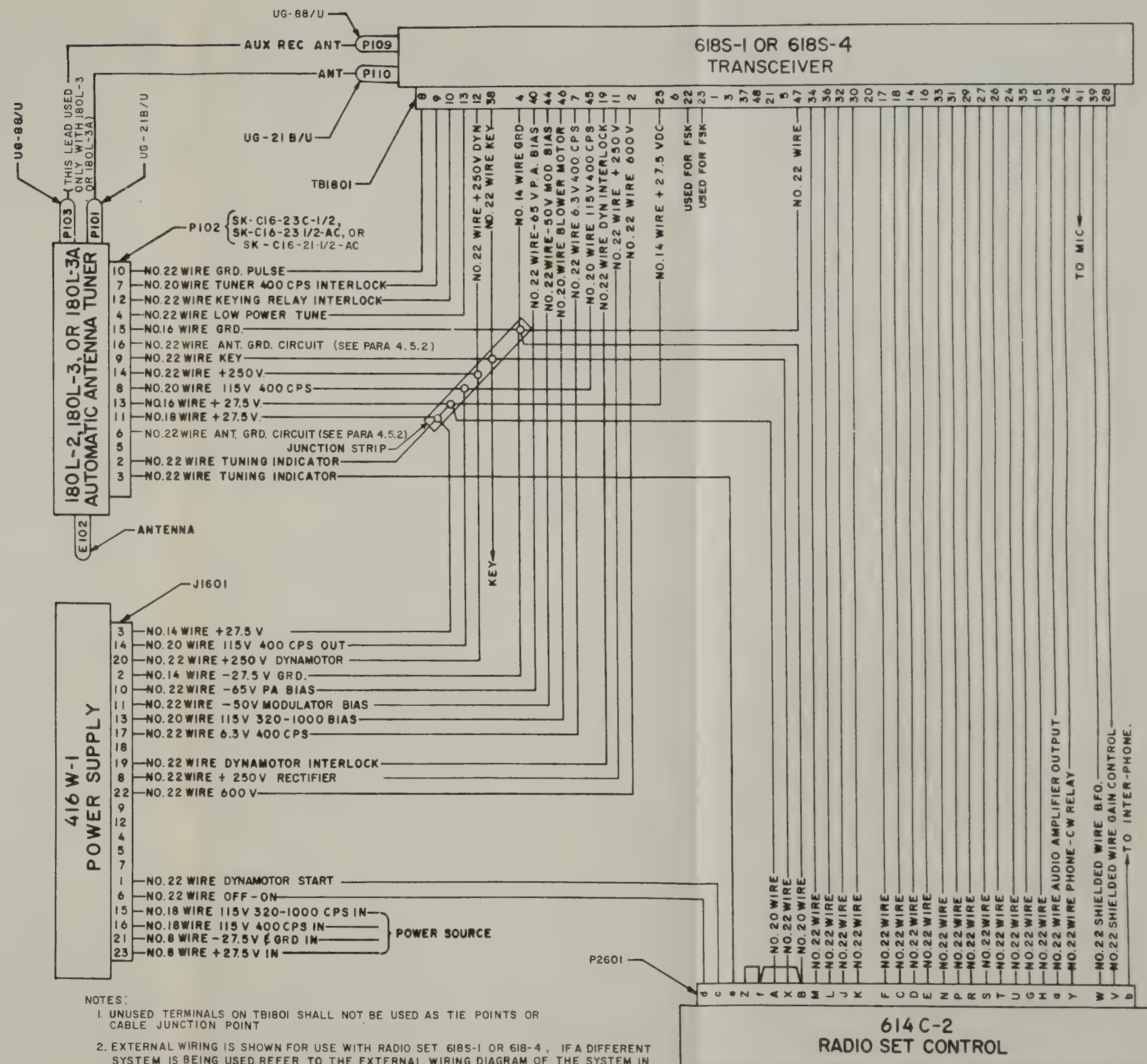
* MAX RELAY CONTACT CURRENT RATING

** ADDITIONAL CURRENT DRAINS DEPEND UPON TRANSMITTER USED

NOTES:

1. APPROXIMATE WEIGHT 21 LBS
2. 16 MTG HOLES .196 DIA
3. ALL DIMENSIONS ARE IN INCHES
4. CLEARANCE OF $\frac{1}{2}$ INCH REQUIRED ON ALL SIDES AND TOP FOR FREE MOVEMENT OF UNIT ON SHOCKMOUNT
5. SPOT FACE 4 OF 16 MOUNTING HOLES FOR CONTACT WITH GROUNDING STRIPS
6. 8 INCH CLEARANCE REQUIRED AT FRONT FOR REMOVAL OF CONNECTOR AND FRONT PANEL
7. PINS 6 AND 16 OF P-102 ARE USED ONLY ON 180L-3A

Figure 7-2. Automatic Antenna Tuner 180L-3 or 180L-3A, Outline and Mounting Dimensions

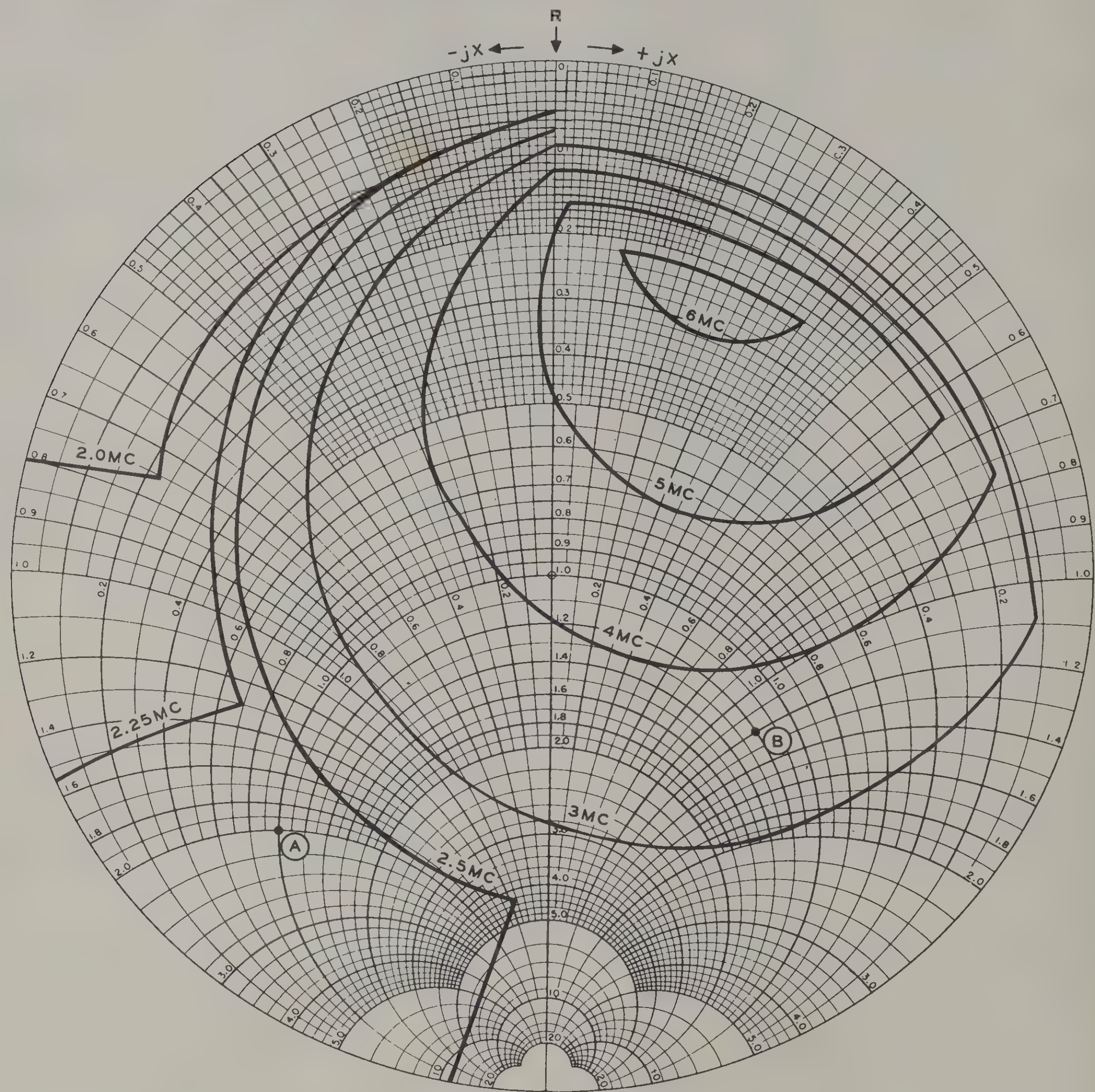


NOTES:
1. UNUSED TERMINALS ON TB1801 SHALL NOT BE USED AS TIE POINTS OR CABLE JUNCTION POINT
2. EXTERNAL WIRING IS SHOWN FOR USE WITH RADIO SET 618S-1 OR 618-4, IF A DIFFERENT SYSTEM IS BEING USED, REFER TO THE EXTERNAL WIRING DIAGRAM OF THE SYSTEM IN USE FOR CONNECTIONS.

Figure 7-3. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, External Wiring Diagram Using Transceiver 618S-1 or 618S-4

180L-2, 180L-3 AND 180L—3A
APPROXIMATE ANTENNA TUNING RANGE

TUNING RANGE IS REPRESENTED BY AREA BETWEEN FREQUENCY CURVES AND OUTSIDE CIRCUMFERENCE. BELOW 3MC. USE ONLY -jX VALUES. THE MINIMUM TUNABLE R COMPONENT IS 1.5 OHMS. INTERPOLATE BETWEEN FREQUENCY CURVES. TUNING RANGE IS APPROXIMATE. EXACT TUNING RANGE DEPENDS ON THE INSTALLATION.



MULTIPLY SCALE BY 1000
TO OBTAIN VALUE IN OHMS

EXAMPLE 1:
AN ANTENNA WITH CHARACTERISTICS 1000 − j 2000 FALLS AT POINT (A) AND CAN BE TUNED AT 3MC BUT CANNOT BE TUNED AT 2MC.

EXAMPLE 2:
AN ANTENNA WITH CHARACTERISTICS 1200 + j1200 FALLS AT POINT (B) AND CAN BE TUNED AT 4MC BUT CANNOT BE TUNED AT 3MC.

Figure 7-4. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Antenna Tuning Limits

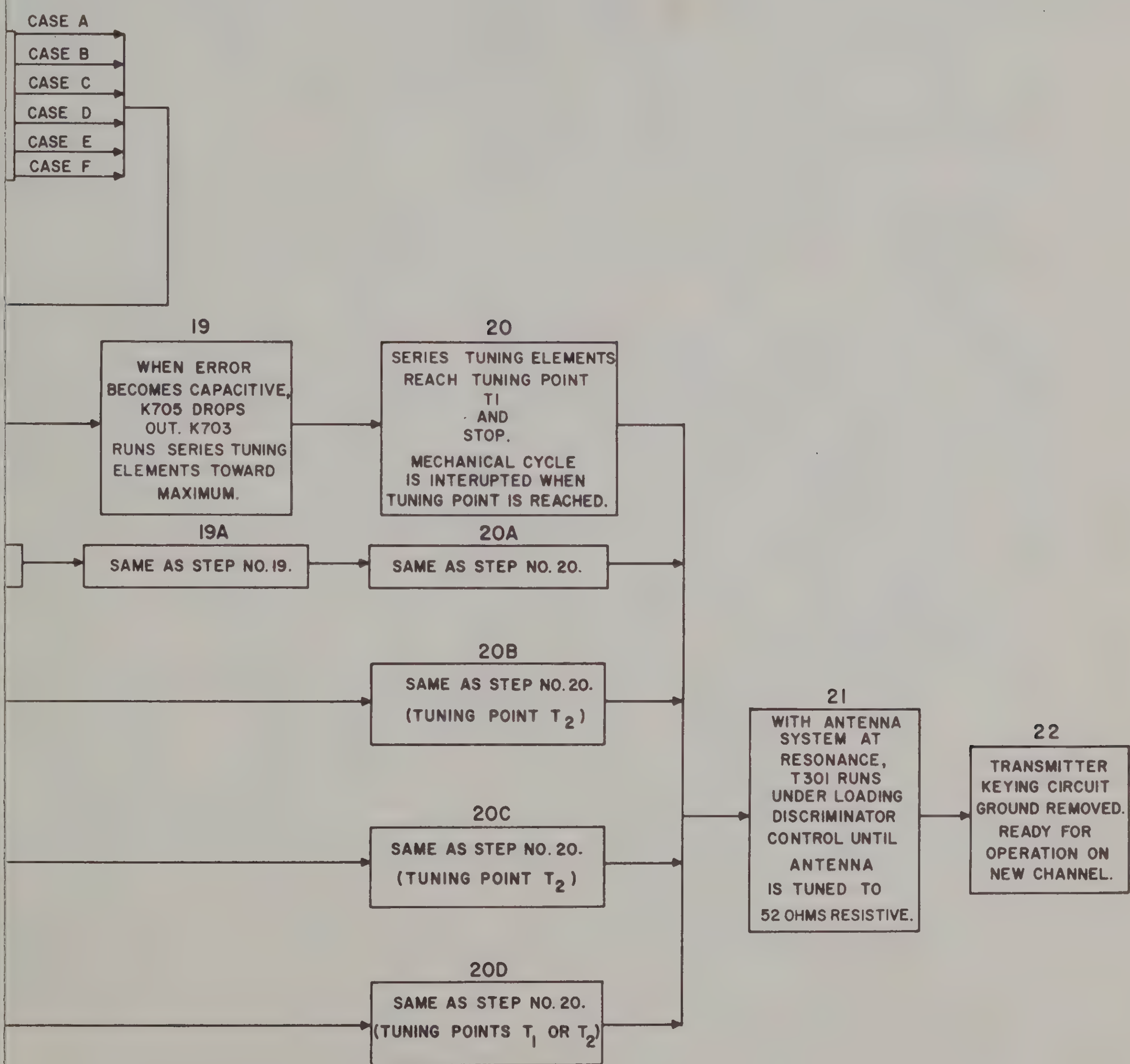
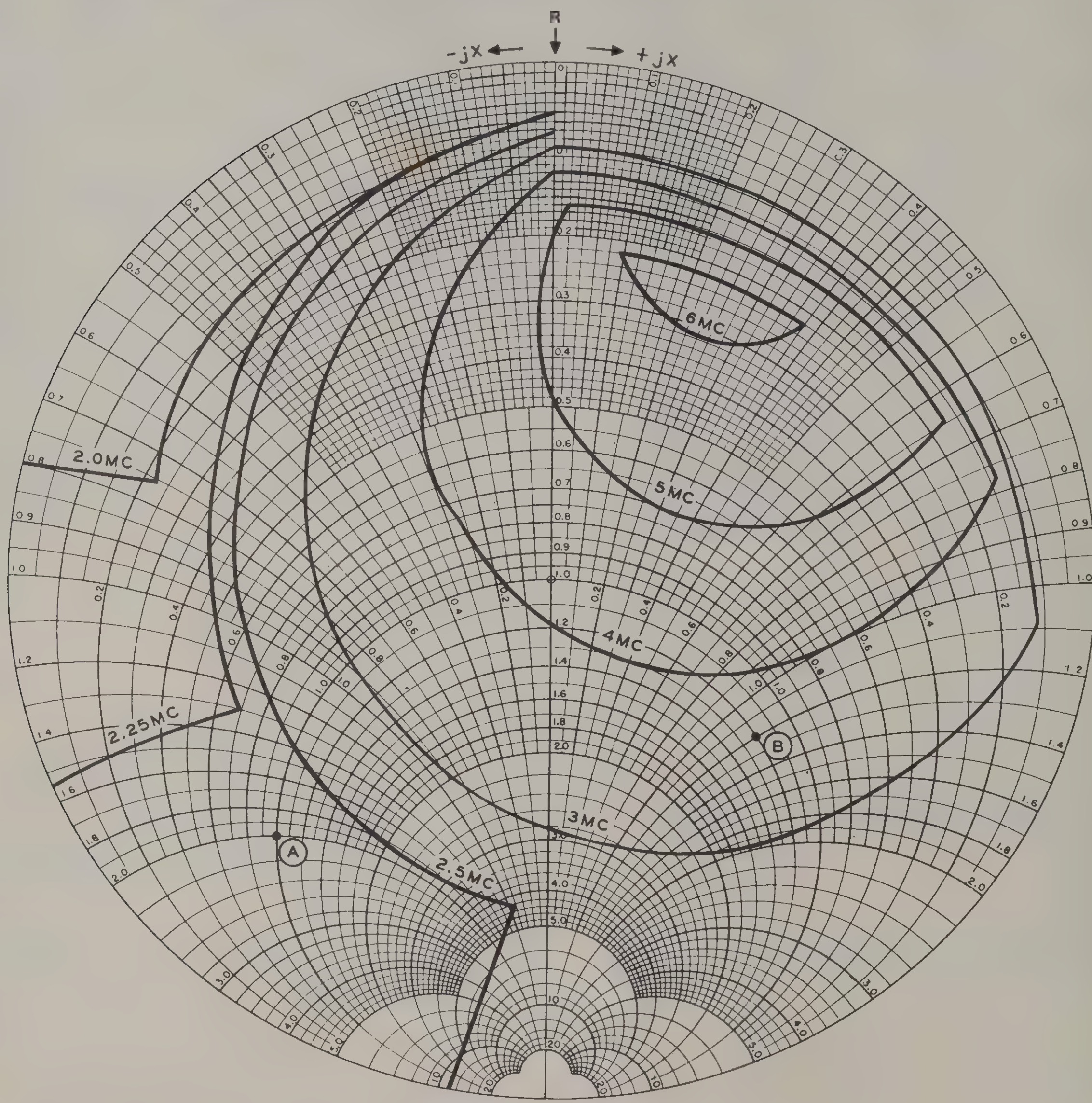


Figure 7-5. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Control Circuits, Complete Sequence of Operation

180L-2, 180L-3 AND 180L-3A
APPROXIMATE ANTENNA TUNING RANGE

TUNING RANGE IS REPRESENTED BY AREA BETWEEN FREQUENCY CURVES AND OUTSIDE CIRCUMFERENCE. BELOW 3MC. USE ONLY -jX VALUES. THE MINIMUM TUNABLE R COMPONENT IS 1.5 OHMS. INTERPOLATE BETWEEN FREQUENCY CURVES. TUNING RANGE IS APPROXIMATE. EXACT TUNING RANGE DEPENDS ON THE INSTALLATION.



MULTIPLY SCALE BY 1000
TO OBTAIN VALUE IN OHMS

EXAMPLE 1:
AN ANTENNA WITH CHARACTERISTICS 1000 - j 2000 FALLS AT POINT (A) AND CAN BE TUNED AT 3MC BUT CANNOT BE TUNED AT 2MC.

EXAMPLE 2:
AN ANTENNA WITH CHARACTERISTICS 1200 + j1200 FALLS AT POINT (B) AND CAN BE TUNED AT 4MC BUT CANNOT BE TUNED AT 3MC.

Figure 7-4. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Antenna Tuning Limits

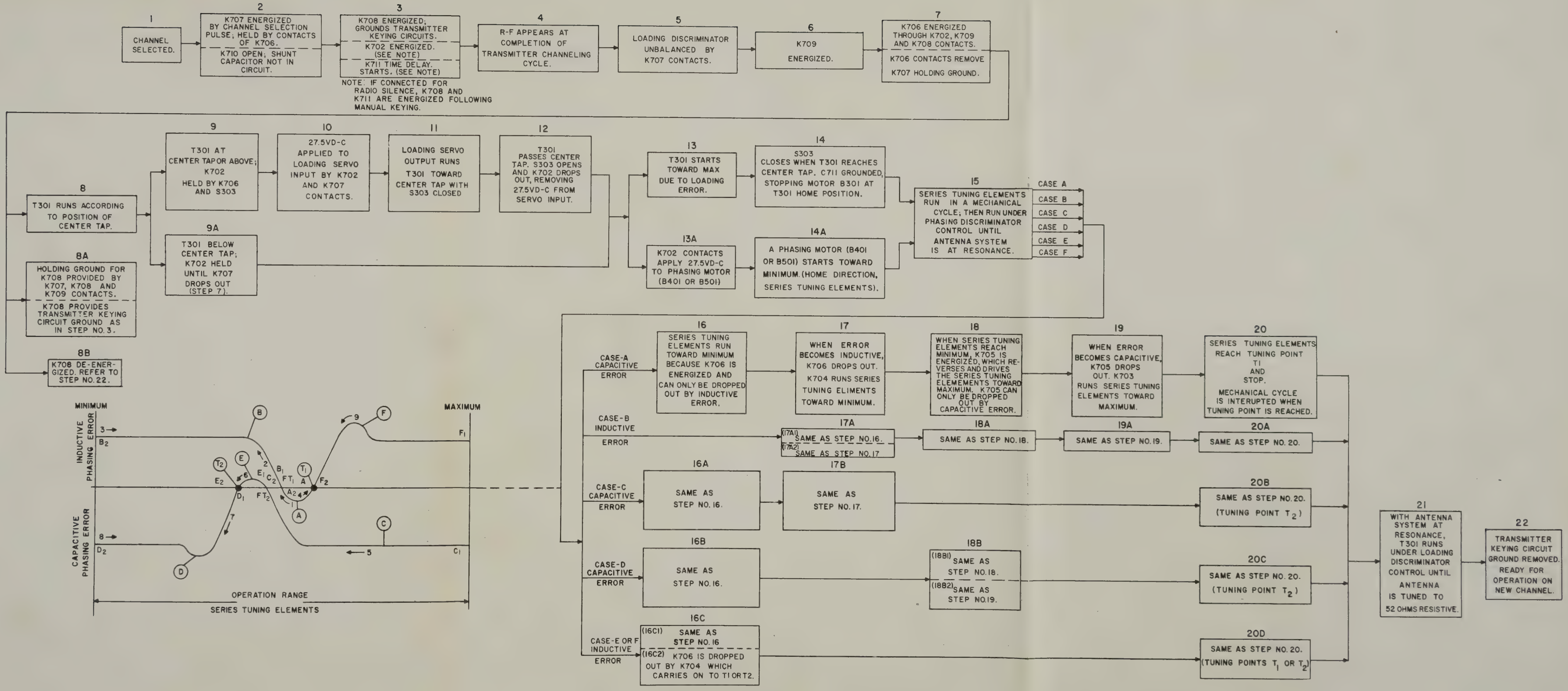
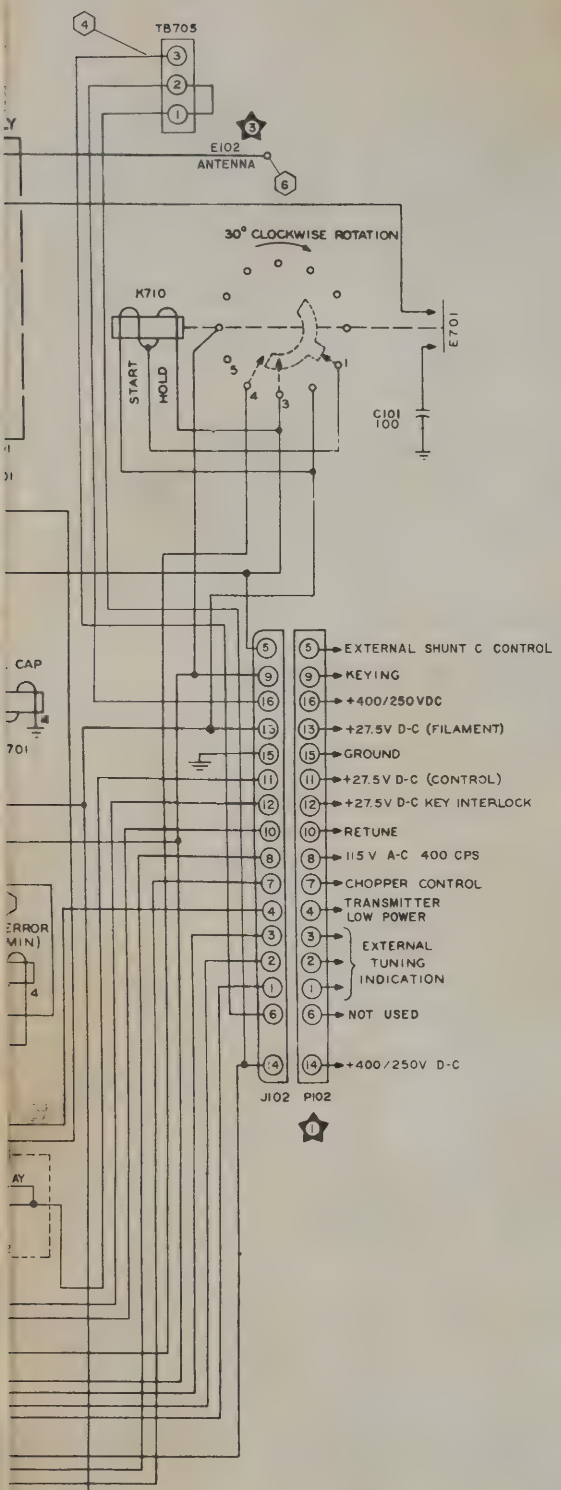


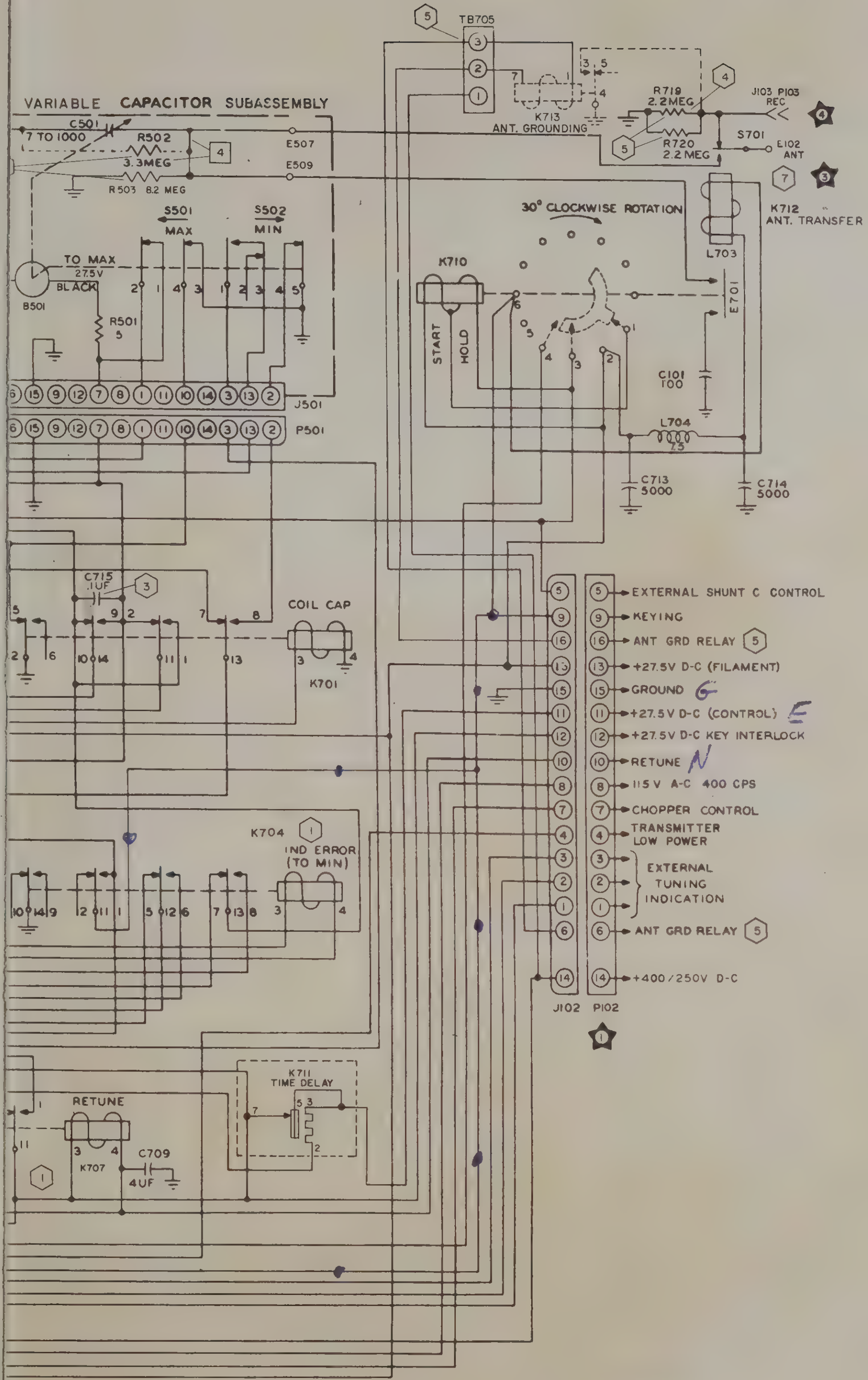
Figure 7-5. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Control Circuits, Complete Sequence of Operation



NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRYS.

MODIFICATION DATA:

1 REFER TO PARA 8.2.1.a
2 REFER TO PARA 8.2.1.b
3 REFER TO PARA 8.2.1.C
4 REFER TO PARA 8.2.1.d
5 REFER TO PARA 8.2.2.a
6 REFER TO PARA 8.2.3.a
7 REFER TO PARA 8.2.4.a
8 REFER TO PARA 8.2.4.b
9 REFER TO PARA 8.2.5.a
10 REFER TO PARA 8.2.5.c
11 REFER TO PARA 8.2.6.a
12 REFER TO PARA 8.2.6.b
13 REFER TO PARA 8.2.6.c
14 REFER TO PARA 8.2.6.e
15 REFER TO PARA 8.2.8.a
16 REFER TO PARA 8.2.2.b
17 REFER TO PARA 8.2.10
18 REFER TO PARA 8.2.11



NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICRO-MICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRYS.

MODIFICATION DATA:
IN THE FOLLOWING MODIFICATION DATA, CHANGES TO 180L-3 CIRCUITRY ARE INDICATED BY A HEXAGON (⬡), AND CHANGES TO 180L-3A CIRCUITRY ARE INDICATED BY A SQUARE (□).

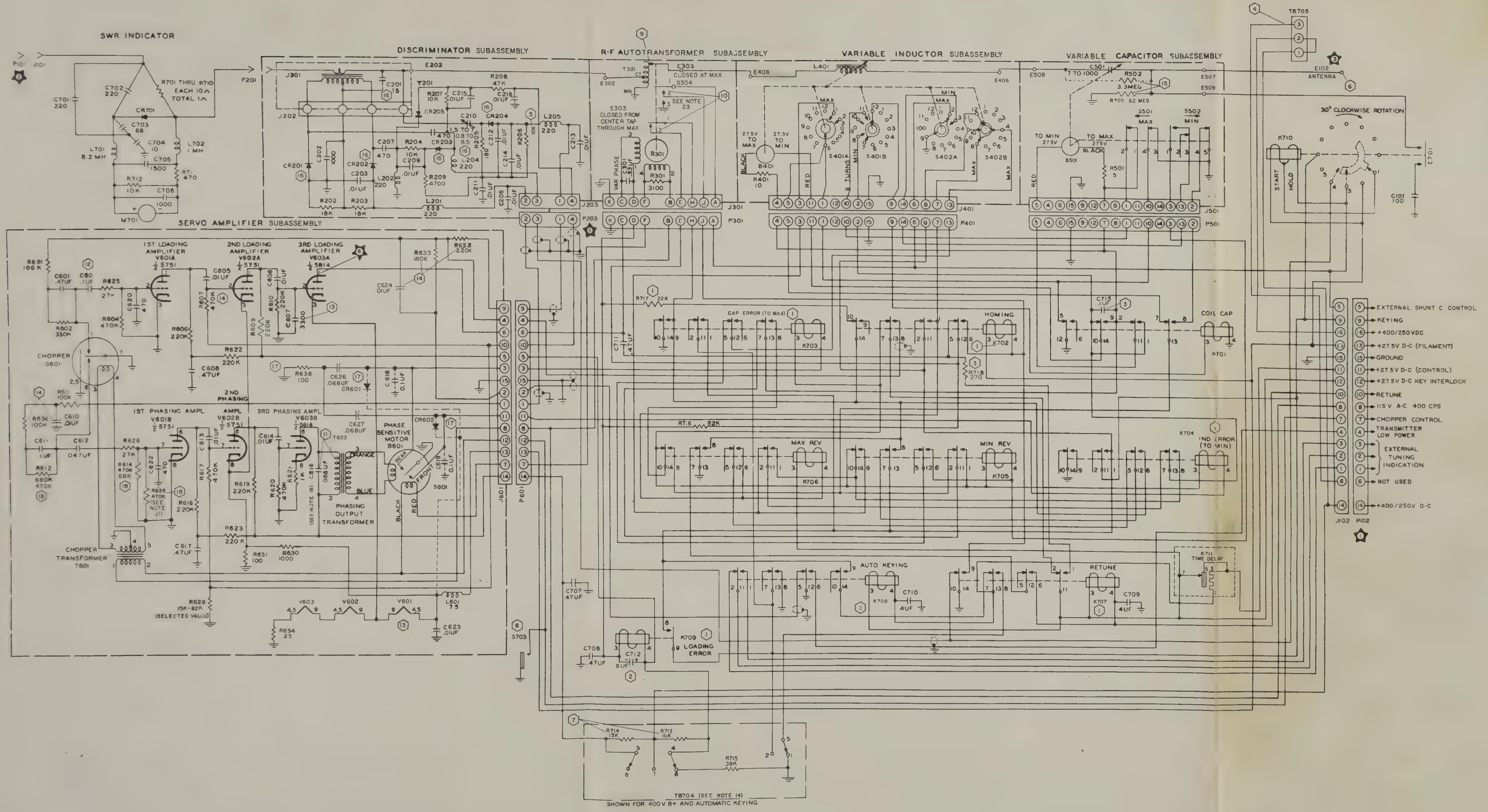
MODIFICATION DATA: 180L-3

1. REFER TO PARAGRAPH 8.3.1.a.
2. REFER TO PARAGRAPH 8.3.1.b.
3. REFER TO PARAGRAPH 8.3.1.c.
4. REFER TO PARAGRAPH 8.3.1.d.
5. REFER TO PARAGRAPH 8.3.1.e.
6. REFER TO PARAGRAPH 8.3.2.a.
7. REFER TO PARAGRAPH 8.3.3.a.
8. REFER TO PARAGRAPH 8.3.4.a.
9. REFER TO PARAGRAPH 8.3.4.b.
10. REFER TO PARAGRAPH 8.3.5.a.
11. REFER TO PARAGRAPH 8.3.5.c.
12. REFER TO PARAGRAPH 8.3.6.a.
13. REFER TO PARAGRAPH 8.3.6.b.
14. REFER TO PARAGRARH 8.3.6.c.
15. REFER TO PARAGRAPH 8.3.6.e.
16. REFER TO PARAGRAPH 8.3.8.a.
17. REFER TO PARAGRAPH 8.3.2.b.
18. REFER TO PARAGRAPH 8.3.10

MODIFICATION DATA: 180L-3A

1. REFER TO PARAGRAPH 8.4.1.a.
2. REFER TO PARAGRAPH 8.4.2.a.
3. REFER TO PARAGRAPH 8.4.3.b.
4. REFER TO PARAGRAPH 8.4.5.a.
5. REFER TO PARAGRAPH 8.4.6
6. REFER TO PARAGRAPH 8.4.7

Figure 7-7. Automatic Antenna Tuner 180L-3 or 180L-3A, Schematic Diagram

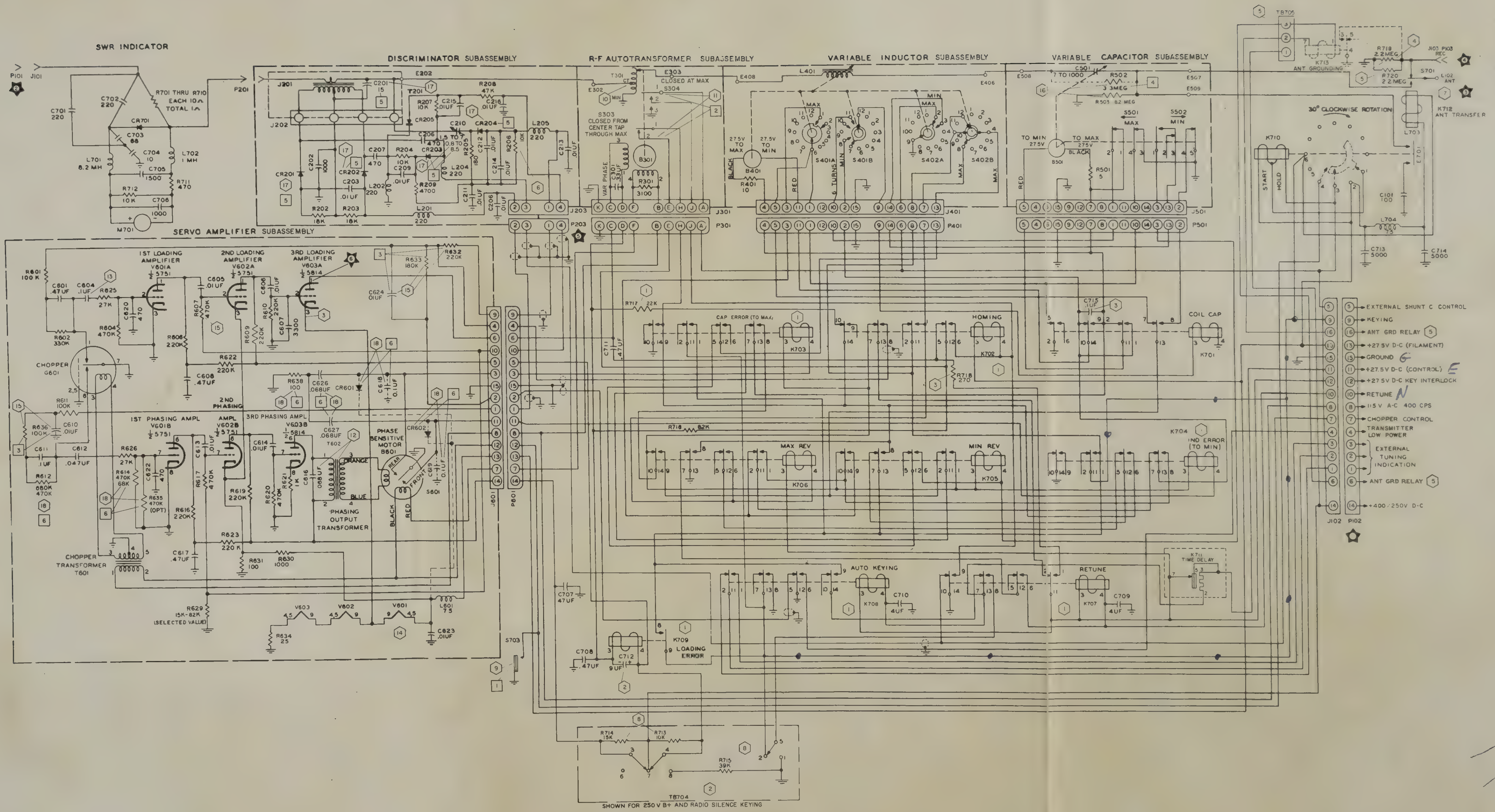


NOTE:
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRYS.

MODIFICATION DATA:

1 REFER TO PARA 8.2.1.a
2 REFER TO PARA 8.2.1.b
3 REFER TO PARA 8.2.1.C
4 REFER TO PARA 8.2.1.d
5 REFER TO PARA 8.2.2.a
6 REFER TO PARA 8.2.3.a
7 REFER TO PARA 8.2.4.a
8 REFER TO PARA 8.2.4.b
9 REFER TO PARA 8.2.5.a
10 REFER TO PARA 8.2.5.c
11 REFER TO PARA 8.2.6.a
12 REFER TO PARA 8.2.6.b
13 REFER TO PARA 8.2.6.c
14 REFER TO PARA 8.2.6.e
15 REFER TO PARA 8.2.8.a
16 REFER TO PARA 8.2.2.b
17 REFER TO PARA 8.2.10
18 REFER TO PARA 8.2.11

Figure 7-6. Automatic Antenna Tuner 180L-2, Schematic Diagram



NOTE
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICRO-MICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRYS.

MODIFICATION DATA:
IN THE FOLLOWING MODIFICATION DATA, CHANGES TO 180L-3 CIRCUITRY ARE INDICATED BY A HEXAGON (⬡), AND CHANGES TO 180L-3A CIRCUITRY ARE INDICATED BY A SQUARE (□)

MODIFICATION DATA: 180L-3
1 REFER TO PARAGRAPH 8.3.1.a
2 REFER TO PARAGRAPH 8.3.1.b.
3 REFER TO PARAGRAPH 8.3.1.c
4 REFER TO PARAGRAPH 8.3.1.d
5 REFER TO PARAGRAPH 8.3.1.e.
6 REFER TO PARAGRAPH 8.3.2.a
7 REFER TO PARAGRAPH 8.3.3.a
8 REFER TO PARAGRAPH 8.3.4.a.
9 REFER TO PARAGRAPH 8.3.4.b
10 REFER TO PARAGRAPH 8.3.5.a.
11 REFER TO PARAGRAPH 8.3.5.c.
12 REFER TO PARAGRAPH 8.3.6.a.
13 REFER TO PARAGRAPH 8.3.6.b.
14 REFER TO PARAGRAPH 8.3.6.c
15 REFER TO PARAGRAPH 8.3.6.e.
16 REFER TO PARAGRAPH 8.3.8.a.
17 REFER TO PARAGRAPH 8.3.2.b.
18 REFER TO PARAGRAPH 8.3.10

MODIFICATION DATA: 180L-3A
1 REFER TO PARAGRAPH 8.4.1.a
2 REFER TO PARAGRAPH 8.4.2.a
3 REFER TO PARAGRAPH 8.4.3.b.
4 REFER TO PARAGRAPH 8.4.5.a.
5 REFER TO PARAGRAPH 8.4.6
6 REFER TO PARAGRAPH 8.4.7

Figure 7-7. Automatic Antenna Tuner 180L-3 or 180L-3A, Schematic Diagram

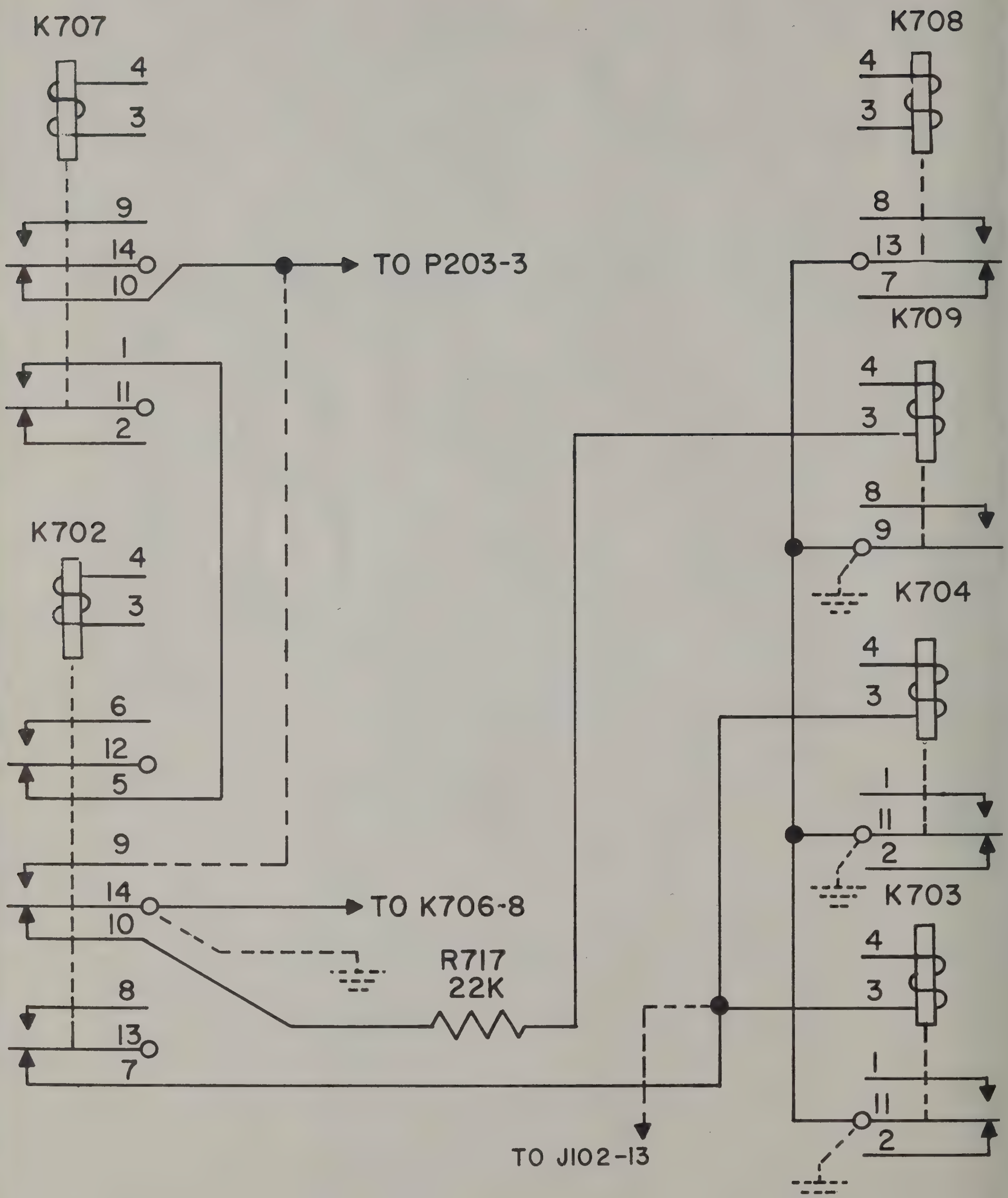


Figure 8-1. Automatic Antenna Tuner 180L-2 or 180L-3, Cable MOD 1 Changes

SECTION VIII
MODIFICATION DATA

8.1 GENERAL.

This section provides information concerning modifications made to this equipment previous to and including the most recent modifications. The most recent modifications included in this book are listed in paragraph 1.1.2. No attempt is made to provide instructions for making modifications to the equipment. (Instructions for making modifications can be found in field service bulletins obtainable from the Collins Radio Company Sales Service Department.) Information is provided pertaining to the condition previous to, the change made by, and the reason for the modification. In some instances, changes were made without assigning a MOD number to the subassembly changed. When this is the case, the changes are identified by serial number effectivity. Due to some modifications, there are electrical and mechanical differences of various serial-numbered equipments which put certain restrictions upon subassembly and component interchangeability. These restrictions are included along with the modifications that introduced the restrictions. Modifications involving only minor hardware changes are not included in this section.

8.2 ANTENNA TUNER 180L-2.

8.2.1 CABLE.

a. The following changes were made by MOD 1 to improve automatic key holding when used with Transceiver 618S-1 or 618S-4: Resistor R717 (22K ohms) was added between terminal 3 of K709 and terminal 10 of K702; terminal 14 of K702 was removed from ground and connected to terminal 8 of K706; terminal 3 of P203 was disconnected from terminal 9 of K702 and connected to terminal 10 of K707; a jumper was added between terminal 1 of K707 and terminal 5 of K702; terminal 11 of K703; terminal 11 of K704, and terminal 9 of K709 were removed from ground and connected to terminal 13 of K708; terminal 3 of K704 was disconnected from terminal 13 of J102 and connected to terminal 7 of K702. Previous to MOD 1, it was necessary to remove resistor R716 when the 180L-2 was used with Transceiver 618S-1 or 618S-4. With MOD 1, this is no longer necessary. Refer to figure 8-1 for a partial schematic diagram illustrating the MOD 1 changes. The connections prior to MOD 1 are indicated with dotted lines. All connections not shown in figure 8-1 have not been changed.

b. Capacitor C712 was changed from two series connected 4-uf capacitors to one 9-uf capacitor, and terminal board TB704 was added by MOD 2. TB704 provides terminals and movable straps for selecting 400-volt or 250-volt plate voltage and automatic keying or radio silence keying.

c. R718 (270 ohms) and C715 (0.1 uf) were added by MOD 3. R718 is a current limiting resistor which prevents damage to relay contacts, and C715 is a spark suppressor on motor relay contacts.

d. Terminal board TB705 was added by MOD 4.

8.2.2 DISCRIMINATOR.

a. The jumper wire from J203 terminal 3 to R206 was removed, and the ground end of L204 was removed from ground and connected to J203 terminal 3 by MOD 1. These changes were necessary to provide for changes made by cable MOD 1. Therefore, discriminators marked MOD 1 must be used with cables marked MOD 1 or higher.

b. MOD 2 changed C201 for improved r-f voltage rating. C210 was changed to 0.8 to 8.5 pf. CR201, CR202, CR203, and CR204 were changed to 1N39B. These changes, effective serial number 3136, were made for improved discriminator reliability.

8.2.3 FRONT PANEL.

a. Antenna terminal E102 was replaced with a clamping-type terminal to reduce the possibility of breakage that was present with the old tape. This change effective with 180L-2 serial numbers 1917 through 2311 and 2452 and up.

8.2.4 MAIN CHASSIS.

a. Resistor R713 was changed from a 2-watt to a 5-watt power rating, and R714 and R715 were changed type effective 180L-2 serial numbers 1843 through 2311 and 2438 and up. These changes were made to prevent circuit changes of cable MOD 1 from overloading the old resistors.

b. A thermostat switch S703, was added to switch the fixed phase winding of B301 on continuously at approximately -30 degrees centigrade. This change effective with 180L-2 serial numbers 2249 through 2311 and 2474 and up.

8.2.5 R-F AUTOTRANSFORMER.

a. The roller and shaft of T301 were changed to an improved type. 180L-2 serial number effectivity for roller change: 1812 through 2311 and 2451 and up. 180L-2 serial number effectivity of shaft change: 1916 through 2311 and 2451 and up.

b. Switch S302B contact 4 was removed from ground and connected to switch S301 contact 1 by MOD 2 to cause homing relay K702 and shunt C switch K710 to operate simultaneously when autotransformer T301 reaches maximum.

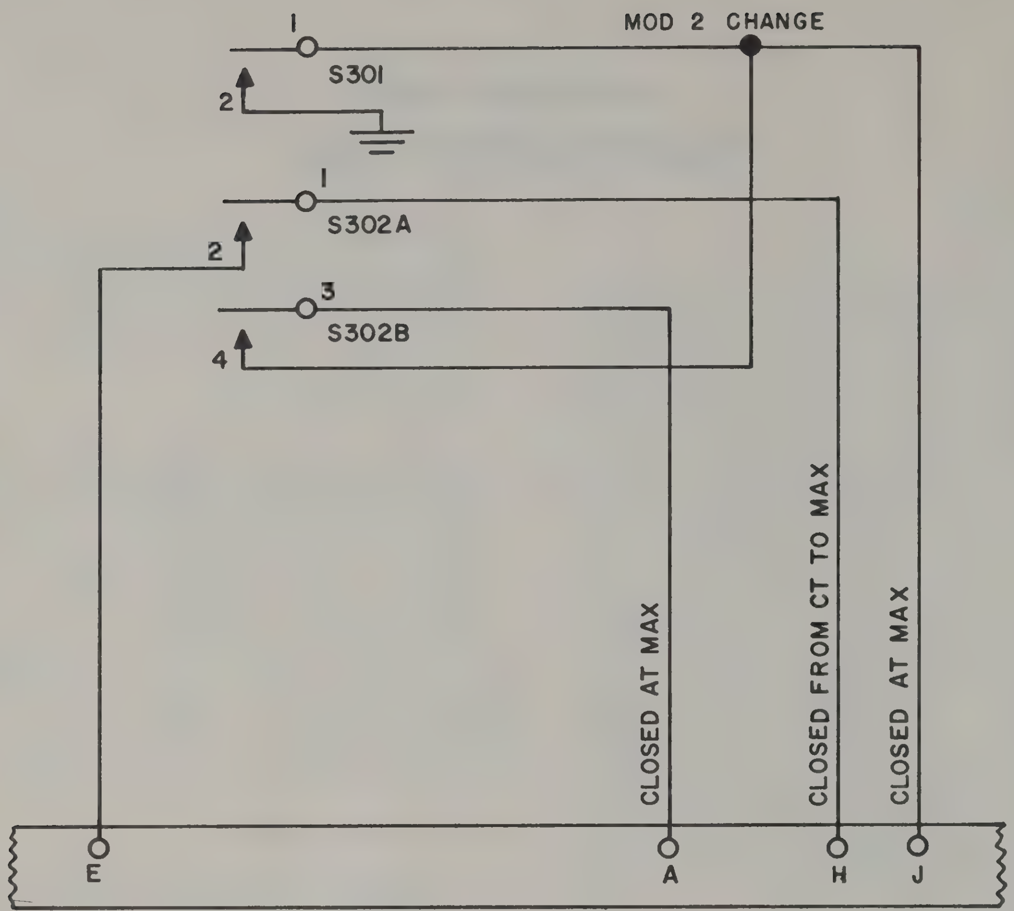


Figure 8-2. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Autotransformer Control Switches Previous to MOD 3

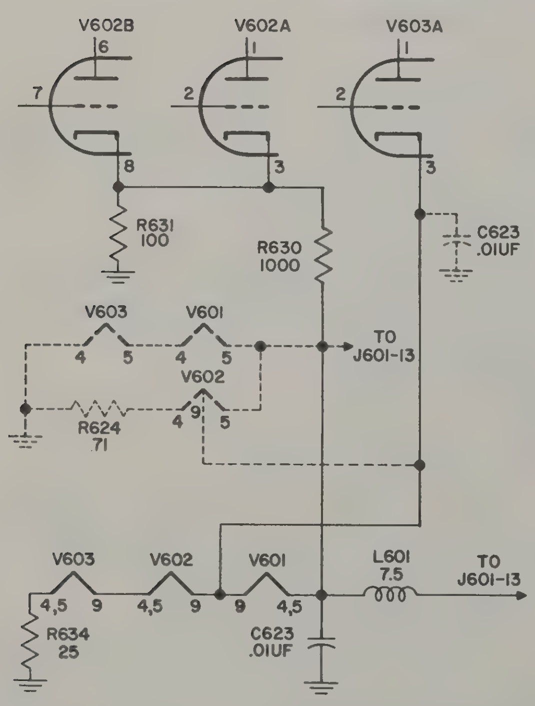


Figure 8-3. Automatic Antenna Tuner 180L-2 or 180L-3, Servo-Amplifier MOD 3 Changes

c. Switches S301 and S302 were replaced with switches S303 and S304 by MOD 3 to improve reliability and ease of synchronizing control switches. The control switches were wired according to figure 8-2 previous to MOD 3.

8.2.6 SERVO AMPLIFIER.

a. Phasing servo transformer T602 was replaced with an improved model, and C616 was changed from 0.1 uf to 0.068 uf by MOD 1 to prevent saturation when plate current flows through the primary of T602.
b. Capacitor C604 was changed from 0.01 uf to 0.1 uf by MOD 2 to improve the loading amplifier sensitivity.
c. The following changes were made by MOD 3 to eliminate the parallel filament circuit, to allow tubes to operate with rated nominal filament voltage, and to provide more adequate r-f filtering of the filament and bias circuits: Resistor R624 (71 ohms) was changed to resistor R634 (25 ohms) and relocated as shown in figure 8-3, inductor L601 (7.5 mh) was added, and the filament circuit was rewired according to figure 8-3. Figure 8-3 is a partial schematic diagram illustrating the MOD 3 changes. The connections prior to MOD 3 are indicated with dotted lines. All connections not shown in figure 8-3 have not been changed.

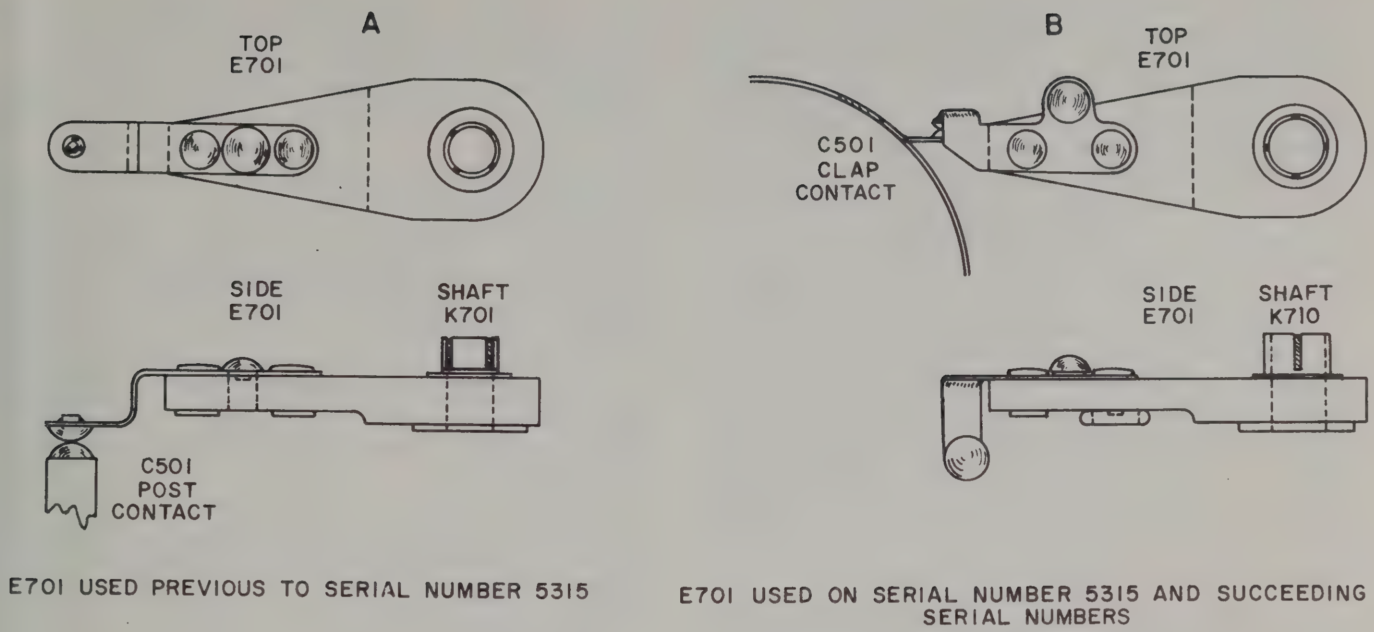


Figure 8-4. Automatic Antenna Tuner 180L-2, 180L-3, or 180L-3A, Shunt C Arm E701, Modification

d. The tube shields were changed to a new heat reduction type effective 180L-2 serial number 2855.

e. The following changes were made by MOD 4 to improve stability of the servo system in the higher frequency range (18 mc): R632 was changed from 22K ohms to 220 K ohms, R633 was changed from 18K ohms to 180K ohms, C610 was changed from 0.0015 uf to 0.01 uf, C624 (0.01 uf) and R636 (100K ohms) were added, and R607 was removed from ground and connected to the avc line.

8.2.7 SHUNT C SWITCH.

a. The C501 post contact was replaced by a clamp contact, and shunt C arm E701 was changed type effective 180L-2 serial number 2855. Equipments using the shunt C arm, E701, shown in figure 8-4A, require the use of variable capacitor MOD 1 or below. Equipments using the shunt C arm, E701, shown in figure 8-4B, require the use of variable capacitor MOD 2 or higher.

8.2.8 VARIABLE CAPACITOR.

a. R502 was deleted, and R503 (8200K ohms) was added from the antenna side of C501 to ground by MOD 1 to eliminate failure of the static drain resistor due to transmission voltages.

b. Variable capacitor assembly was changed type by Mod 2 to improve the reliability and adjustment of the shunt C switch. Refer to paragraph 8.2.7a.

8.2.9 VARIABLE INDUCTOR.

a. Mechanical changes were made by MOD 1 to reduce gear wobble, noise, and wear.

b. Variable inductor subassembly was changed in type by MOD 2 to one with a strengthened mechanical structure.

8.2.10 SERVO STABILITY.

a. MOD 5 deleted C618 and C619 and replaced with CR601 and CR602, 1N645's. This reduces pitting of S601 contacts. This change is effective serial number 3136.

b. MOD 7 deleted CR601 and CR602 and added C626, C627, and R638. This change effective serial number 3368, improves dropout time of relays K703 and K704.

8.2.11 SERVO STABILITY.

a. Effective serial number 3062, R612 changed to 470K, R614 changed to 68K, and R635 deleted. This change improves servo stability in 2-8-mc range when tuning short antennas. This change was MOD 6.

8.3 ANTENNA TUNER 180L-3.

8.3.1 CABLE.

a. The following changes were made by MOD 1 to improve automatic key holding when used with the Transceiver 618S-1 or 618S-4: Resistor R717 (22K ohms) was added between terminal 3 of K709 and terminal 10 of K702; terminal 14 of K702 was removed from ground and connected to terminal 8 of K706; terminal 3 of P203 was disconnected from terminal 9 of K702 and connected to terminal 10 of K707; a jumper was added between terminal 1 of K707 and terminal 5 of K702; terminal 11 of K703, terminal 11 of K704, and

terminal 9 of K709 were removed from ground and connected to terminal 13 of K708; terminal 3 of K704 was disconnected from terminal 13 of J102 and connected to terminal 7 of K702. Previous to MOD 1, it was necessary to remove resistor R716 when the 180L-3 was used with Transceiver 618S-1 or 618S-4. With MOD 1, this is no longer necessary. Refer to figure 8-1 for a partial schematic diagram illustrating the MOD 1 changes. The connections prior to MOD 1 are indicated with dotted lines. All connections not shown in figure 8-1 have not been changed.

b. Capacitor C712 was changed from two series-connected, 4-uf capacitors to one 9-uf capacitor, and terminal board TB704 was added by MOD 2. TB704 provides terminals and movable straps for selecting 400-volt or 250-volt plate voltage and automatic keying or radio silence keying.

c. R718 (270 ohms) and C715 (0.1 uf) were added by MOD 3. R718 is a current limiting resistor which prevents damage to relay contacts, and C715 is a spark suppressor on motor relay contacts.

d. R719 (1000K ohms) was added effective 180L-3 serial number 2085. This resistor provides static drain for the antenna during reception.

e. The following changes were made by MOD 4 to permit the 180L-3 to be converted to 180L-3A by simply plugging in one new relay, K713. Terminal board TB705 was added; resistor R719 was changed from 1000K ohms, 1 watt to 2200K ohms, 1/2 watt; resistor R720 (2200K ohms, 1/2 watt) was added in parallel with R719; and mounting bracket A705 was added. For information on a dual installation using relay K713, refer to paragrapb 4.5.2.

8.3.2 DISCRIMINATOR.

a. The jumper wire from J203 terminal 3 to R206 was removed, and the ground end of L204 was removed from ground and connected to J203 terminal 3 by MOD 1. These changes were necessary to provide for changes made by cable MOD 1. Therefore, discriminators marked MOD 1 must be used with cables marked MOD 1 or higher.

b. MOD 2 changed C201 for improved r-f voltage rating. C210 changed to 0.8 to 8.5 pf. CR201, CR202, CR203, and CR204 were changed to 1N39B. These changes, effective serial number 6502, were made for improved discriminator reliability.

8.3.3 FRONT PANEL.

a. Antenna terminal E102 was replaced with a clamping-type terminal to reduce the possibility of breakage that was present with the old type. This change effective with 180L-3 serial numbers 810 through 979 and 1253 and up.

8.3.4 MAIN CHASSIS.

a. Resistor R713 was changed from a 2-watt to a 5-watt power rating, and R714 and R715 were changed type effective 180L-3 serial numbers 176 through 257 and 661 and up. These changes were made to prevent circuit changes of cable MOD 1 from overloading the old resistors.

b. A thermostat switch, S703, was added to switch the fixed phase winding of B301 on continuously at approximately -30 degrees centigrade. This change was effective with 180L-3 serial numbers 2941 through 3114 and 3135 and up.

8.3.5 R-F AUTOTRANSFORMER.

a. The roller and shaft of T301 were changed to an improved type. 180L-3 serial number effectivity for roller change, 233 through 257 and 661 and up. 180L-3 serial number effectivity for shaft change: 810 through 979 and 1226 and up.

b. Switch S302B contact 4 was removed from ground and connected to switch S301 contact 1 by MOD 2 to cause homing relay K702 and shunt C switch K710 to operate simultaneously when autotransformer T301 reaches maximum.

c. Switches S301 and S302 were replaced with switches S303 and S304 by MOD 3 to improve reliability and ease of synchronizing control switches. The control switches were wired according to figure 8-2 previous to MOD 3.

8.3.6 SERVO AMPLIFIER.

a. Phasing servo transformer T602 was replaced with an improved model, and C616 was changed from 0.1 uf to 0.068 uf by MOD 1 to prevent saturation when plate current flows through the primary of T602.

b. Capacitor C604 was changed from 0.01 uf to 0.1 uf by MOD 2 to improve the loading amplifier sensitivity.

c. The following changes were made by MOD 3 to eliminate the parallel filament circuit, to allow tubes to operate with rated nominal filament voltage, and to provide more adequate r-f filtering of the filament and bias circuits: Resistor R624 (71 ohms) was changed to resistor R634 (25 ohms) and relocated as shown in figure 9-3, inductor L601 (7.5 mh) was added, and the filament circuit was rewired according to figure 8-3. Figure 8-3 is a partial schematic diagram illustrating the MOD 3 changes. The connections prior to MOD 3 are indicated with dotted lines. All connections not shown in figure 8-3 have not been changed.

d. The tube shields were changed to a new heat reduction type effective 180L-3 serial number 5628.

e. The following changes were made by MOD 4 to improve stability of the servo system in the higher frequency range (18-22 mc): R632 was changed from 22K ohms to 220K ohms, R633 was changed from 18K ohms to 180K ohms, C610 was changed from 0.0015 uf to 0.01 uf, C624 (0.01 uf) and R636 (100K ohms) were added, and R607 was removed from ground and connected to the avc line.

8.3.7 SHUNT C SWITCH.

a. The C501 post contact was replaced by a clamp contact, and shunt C arm E701 was changed type effective 180L-3 serial number 5315. Equipments using the shunt C arm, E701, shown in figure 8-4A require the use of variable capacitor MOD 1 or below. Equipments using the shunt C arm, E701, shown in figure 8-4B, require the use of variable capacitor MOD 2 or higher.

8.3.8 VARIABLE CAPACITOR.

a. R502 was deleted, and R503 (8200K ohms) was added from the antenna side of C501 to ground by MOD 1 to eliminate failure of the static drain resistor due to transmission voltages.
b. Variable capacitor assembly was changed type by MOD 2 to improve the reliability and adjustment of the shunt C switch. Refer to paragraph 8.3.8.a.

8.3.9 VARIABLE INDUCTOR.

a. Mechanical changes were made by MOD 1 to reduce gear wobble, noise, and wear.
b. Variable inductor subassembly was change type by MOD 2 to one with a strengthened mechanical structure.

8.3.10 SERVO STABILITY.

a. MOD 5 deleted C618 and C619, and replaced with CR601 and CR602, 1N645's. This change, effective serial number 6502, reduces pitting of S601 contacts.
b. Effective serial number 6621, R612 changed to 470K, R614 changed to 68K, and R635 deleted. This change, MOD 6, improves servo stability in 2-8-mc range when tuning short antennas.
c. MOD 7 deleted CR601 and CR602, and added C627, C626, .068 uf, and R638 100 ohms. This change was effective serial number 6985 and improves dropout time of relays K703 and K704.

8.4 ANTENNA TUNER 180L-3A.

8.4.1 MAIN CHASSIS.

a. A thermostat switch, S703, was added to switch the fixed phase winding of B301 on continuously at approximately -30 degrees centigrade. This change effective 180L-3A serial number 21.

8.4.2 R-F AUTOTRANSFORMER.

a. Switches S301 and S302 were replaced with switches S303 and S304 by MOD 3 to improve reliability and ease of synchronizing control switches. The control switches were wired according to figure 8-2 previous to MOD 3.

8.4.3 SERVO AMPLIFIER.

a. The tube shields were changed to a new heat reduction-type effective 180L-3A serial number 191.

b. The following changes were made by MOD 4 to improve stability of the servo system in the higher frequency range (18-22 mc): R632 was changed from 22K ohms to 220K ohms, R633 was changed from 18K ohms to 180K ohms, C610 was changed from 0.0015 uf to 0.01 uf, C624 (0.01 uf) and R636 (100K ohms) were added, and R607 was removed from ground and connected to the avc line.

8.4.4 SHUNT C SWITCH.

a. The C501 post contact was replaced by a clamp contact, and shunt C arm E701 was changed type effective 180L-3A serial number 371. Equipments using the shunt C arm, E701, shown in figure 8-4A require the use of variable capacitor MOD 1 or below. Equipments using the shunt C arm, E701, shown in figure 8-4B, require the use of variable capacitor MOD 2 or higher.

8.4.5 VARIABLE CAPACITOR.

a. R502 was deleted, and R503 (8200K ohms) was added from the antenna side of C501 to ground by MOD 1 to eliminate failure of the static drain resistor due to transmission voltages.
b. Variable capacitor assembly was changed type by MOD 2 to improve the reliability and adjustment of the shunt C switch. Refer to paragraph 8.4.4.a.

8.4.6 DISCRIMINATOR

a. MOD 2 changed C201 for improved r-f voltage rating. C210 was changed to 0.8 to 8.5 pf. CR201, CR202, CR203, and CR204 were changed to 1N39B. These changes, effective serial number 563, were made for improved discriminator reliability.

8.4.7 SERVO STABILITY.

a. MOD 5 deleted C618 and C619 and replaced with CR601 and CR602, 1N645's. This change, effective serial number 563, reduces pitting of S601 contacts.
b. Effective serial number 1038, R612 changed to 470K, R614 changed to 68K, and R635 deleted. This change, MOD 6, improves servo stability in 2-8-mc range when tuning short antennas.
c. MOD 7 deleted CR601 and CR602, and added C626, C627, .068 uf, and R638 100 ohms. This change was effective serial number 1406 and improves dropout time of relays K703 and K704.

COLLINS